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# SOYBEAN ROW SPACING AND SOIL WATER SUPPLY:

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Their Effect on Growth, Development,  
Water Relations, and Mineral Uptake



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# SOYBEAN ROW SPACING AND SOIL WATER SUPPLY:

## Their Effect on Growth, Development, Water Relations, and Mineral Uptake<sup>1</sup>

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### INTRODUCTION

Planting soybeans (*Glycine max* (L.) Merr.) in rows more narrowly spaced than the traditional 1.0-m rows often results in increased yields in the midwestern United States (8, 20, 24).<sup>6</sup> The rapid development of an evenly distributed crop canopy by narrow-row soybeans can result in greater radiation interception and photosynthetic rates than those of the partial canopies associated with wider-row spacings (20). The yield advantage of narrow-row soybeans is often attributed to this increased radiation interception (19).

Recent research has shown that increased radiation interception by narrow-row soybeans can result in increased early seasonal soil water use when compared with that of wide-row soybeans, resulting in a strong interaction of water supply and row spacing on final seed yield (24). That is, seed yield in narrow rows was greater only when seasonal water supply was high. However, water supply does not provide the whole answer. In other research, irrigation was used to maintain adequate soil water levels, but no consistent effect of row spacing on final yield was reported (1). Also, Taylor (24) found that in 2 of the 3 years reported, during July and August, plants grow-

ing in 1.0-m rows were taller, had greater leaf area, pod number and total biomass, and higher leaf water potential than plants in 0.25-m rows. Despite these apparent advantages quite late in the season, the 0.25-m row plants always yielded as much or more than those in the 1.0-m rows.

The experimental program reported here had two basic aims. First, we planned to monitor the growth, development, water and nutrient use, and yield of soybeans grown in wide (1.0 m) and narrow (0.25 m) rows under irrigated (I) and nonirrigated (N) conditions to clarify why narrow row soybeans often produce greater yields, and second, to develop this bulletin containing a comprehensive data set useful in validating soybean growth models.

Researchers have spent considerable effort during the 1970's to develop crop growth models. One major aim of these whole-crop models is to predict crop yields, as far in advance as possible, in the United States and in potentially competing countries. Models also have been developed to describe such subsystems as root growth, canopy development, water use, and nutrient uptake of the overall crop models. This data set should prove helpful for validating both types of models.

Much of the data presented here has been or will be published in scientific journals, but only in summarized form or for specific dates. Our aim in this bulletin is to present as much data as possible on soybean responses and, where practical, on an individual replicate basis. This allows for maximum flexibility of usage. We have included full descriptions of all sampling methods, as well as some statistical analysis of the data and some discussion of the results. A more detailed discussion of results is being published (32-36).

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<sup>6</sup>Italic numbers in parentheses refer to Literature Cited p. 58.

## EXPERIMENTAL PROCEDURES

**Plot description and management.**—The experimental data were collected in 1979 at the Western Iowa Experimental Farm, Castana, Iowa. The soil was an Ida silt loam (fine, silty, mixed (calcareous) mesic family of Typic Udorthents) with a slope of about 8 percent to the west. A profile description at the site is as follows:

Horizon	Depth, cm	Morphology <sup>†</sup>
AP1	0-18	Dark brown to brown (10 YR 4/3) when moist; silt loam (6 percent $> 50\mu$ , 75 percent 50-2 $\mu$ , 19 percent $< 2\mu$ ); strong medium fragmental; very friable; low inped porosity and large exped porosity; bulk density $\sim 1.29$ g/cm <sup>3</sup> .
AP2	18-26	Dark brown (10 YR 4/3 to 3/3) silt loam (7 percent $> 50\mu$ , 77 percent 50-2 $\mu$ , 16 percent $< 2\mu$ ); parts massive and parts strong coarse, and medium fragmental; friable; low inped porosity; bulk density $\sim 1.25$ g/cm <sup>3</sup> .
C1	26-38	Brown (10 YR 5/3) silt loam (7 percent $> 50\mu$ , 77 percent $> 50$ -2 $\mu$ , 16 percent $< 2\mu$ ); massive; friable; carbonate nodules 0.5 cm every 5 to 10 cm; fewer roots than horizon beneath; bulk density $\sim 1.25$ g/cm <sup>3</sup> .
C2	38-50	Brown (10 YR 5/3) silt loam (8 percent $> 50\mu$ , 78 percent $> 50$ -2 $\mu$ , 14 percent $< 2\mu$ ); massive to weak coarse subangular blocky; very friable; some carbonate nodules; bulk density $\sim 1.25$ g/cm <sup>3</sup> .
C3	50-75	Brown (10 YR 5/3) silt loam (8 percent $> 50\mu$ , 78 percent 50-2 $\mu$ , 14 percent $< 2\mu$ ); very weak coarse subangular blocky; very friable; few continuous vertical cylindrical voids 0.2 to 0.4 cm in diameter; some carbonate nodules; bulk density $\sim 1.25$ g/cm <sup>3</sup> .
C4	75-104	Brown (10 YR 5/3) with 10 percent to 20 percent medium prominent grayish brown (10 YR 5/2) mottles; silt loam (9 percent $> 50\mu$ , 78 percent 50-2 $\mu$ , 13 percent $< 2\mu$ ); massive; very friable; fewer carbonate nodules than C1, C2, and C3; bulk density $\sim 1.25$ g/cm <sup>3</sup> .
C5	105-124	Dark brown to brown (1/2 10 YR 4/3 and 1/2 10 YR 5/3) with some surfaces brown (7.5 YR 5/3) and with 10 percent grayish brown (10 YR 5/2) silt loam (9 percent $> 50\mu$ , 81 percent 50-2 $\mu$ , 10 percent $< 2\mu$ ); massive, very friable; bulk density $\sim 1.25$ g/cm <sup>3</sup> .

<sup>†</sup> Morphological description by R. B. Grossman and C. R. Berdaniel, National Soil Survey Laboratory, U. S. Department of Agriculture, Soil Conservation Service, Lincoln, Nebr. Bulk density and textural data courtesy S. T. Willatt, La Trobe University, Bundoora, Victoria, Australia.

C6 124-189 Brown (10 YR 5/3) to light olive brown (2.5 YR 5/3) with 20 percent grayish brown (10 YR 5/2); silt loam (10 percent  $> 50\mu$ , 80 percent 50-2 $\mu$ , 10 percent  $< 2\mu$ ); massive; very friable; bulk density  $\sim 1.30$  g/cm<sup>3</sup>.

Other soils data for the site have been published (22, 29, 30).

The experimental area contained a soybean crop in 1978 and remained uncultivated until the area was moldboard-plowed to an 18-cm depth on May 8. We broadcast phosphorus (0-46-0) and potassium (0-0-60) at the rate of 140 kg/ha for each element and disked twice to incorporate. The herbicide Amiben was applied at label rate to control broadleaf weeds and harrowed to incorporate. On May 15 we planted seed of the indeterminate soybean cultivar 'Wayne' (maturity group 3) approximately 2-cm deep. Rows were aligned 15° west of true north.

We divided the experimental area into three replicates for planting, each containing eight rows 1.0-m apart and an equivalent area of rows 0.25-m apart. The planted area was then divided into two treatments, one with rainfall only, and one where rainfall was supplemented by sprinkler irrigation when the soil water content at 0.3 m decreased to 0.20 cm<sup>3</sup>/cm<sup>3</sup>.

When emergence began on May 21, we marked off two 6-m sections of row in each row spacing and took emergence counts daily. By June 4, 100 percent emergence had occurred in most plots, and we began thinning to a uniform population of 160,000 plants per hectare. This resulted in an average interplant spacing of 6.3 cm in the 1.0-m rows and 25 cm in the 0.25-m rows. On June 15 we sprayed the plots with Sevin at label rate to control a range of leaf-eating insects that had caused about 5 percent leaf area damage. Throughout the season, we removed weeds and late emerging soybeans by hand. Final maturity was reached in late September, in the order of nonirrigated 1.0-m rows (N100), nonirrigated 0.25-m rows (N25), irrigated 1.0-m rows (I100), and irrigated 0.25-m rows (I25). We harvested the nonirrigated plots on September 27 and the irrigated plots on October 2.

**Weather measurements.**—Daily precipitation, maximum and minimum air temperature, soil temperature, Class A pan evaporation, and wind run were recorded at a site about 300 m from the plot area. These data are presented here for the 1979 soybean growth season and are continuously available in the Iowa Climatological Summary (27).



**Soil temperature measurements.**—We installed thermistor temperature probes (Series 700 Thermoliner temperature probe, Yellow Springs Instrument Co., Yellow Springs, Ohio) at 0.50-m depth increments to 3.0 m in replicate 2 of each treatment. We read the soil temperatures manually between 1,100 and 1,400 hr (CDT) approximately weekly.

**Radiation interception measurement.**—Several times during canopy development, we took solar radiation readings above and below the crop canopy using a 970-mm tube solarimeter (Delta-T Devices model TSL-76). We took below-canopy readings with the solarimeter resting on the soil surface. For the above-canopy readings, we placed the solarimeter on top of wooden stakes, parallel to the soil surface. We always placed the solarimeter perpendicular to the crop row, with one end at the midpoint between two rows. We took duplicate readings in each replicate between 1,000 and 1,500 hr CDT.

**Soil physical properties.**—We measured bulk density, water retentivity, hydraulic conductivity, and texture on soil from a single site about 50 m from the main experimental area. We took samples at a depth of 0.15 m and then at successive 0.30-m intervals to a depth of 2.55 m (that is, the soil profile was considered to consist of nine layers each 0.30-m thick). We determined dry-bulk density on triplicate soil samples collected in aluminum cylinders 50 mm in diameter by 70 mm high.

We determined water retentivity in the laboratory and from *in situ* field measurements. In the laboratory, the water content of four replicate undisturbed soil samples (50-mm diameter  $\times$  30-mm high) from each depth was determined at pore water pressures of  $-1.0 \times 10^{-3}$ ,  $-2.0 \times 10^{-3}$ ,  $-4.0 \times 10^{-3}$ , and  $8.0 \times 10^{-3}$  MPa on a tension table. We used similar samples to determine the water content at pore water pressures of  $-0.016$ ,  $-0.033$ ,  $-0.050$ , and  $-0.100$  MPa using pressure plate equipment. We soaked the samples overnight by standing them in about 2 mm of water, and some soil swelling was apparent. With pressure membrane equipment, we determined the water content of sieved soil (less than 2.0 mm) at pore water pressures of  $-0.2$ ,  $-0.4$ ,  $-0.8$ , and 1.5 MPa. Again, four replicate samples from each depth were used with fresh soil used for each determination.

We measured hydraulic conductivity-water content relationships in the field by an instantaneous profile method (11). A neutron probe access tube was installed, and a 1-m square block of soil was then isolated around the tube by digging a trench to a depth of 2.7 m on all four sides of the block. We inserted

two replicate sets of tensiometers through opposing vertical faces of the block at 0.15 m and at successive 0.30-m intervals to a depth of 2.55 m. The block was wrapped in polyethylene, the trenches filled, and water ponded on the surface between raised borders for 10 days. After free water had drained from the surface, we covered the soil with polyethylene to prevent evaporation and started measuring soil water content with the neutron probe and pore water pressure with the tensiometers. We measured as frequently as possible during the first day and then at increasing intervals for about 30 days. For any single depth, the hydraulic conductivity (K) at a specific water content was calculated from the equation:

$$K = -q / (dh/dz)$$

where  $q$  is the drainage flux through the appropriate depth plane (positive direction upwards) calculated from the rates of loss of soil water above the plane (derived from the neutron probe results), and  $dh/dz$  is the gradient of hydraulic head ( $h$ ) with depth ( $z$ ), which was calculated from the tensiometer data.

We calibrated the neutron probe for each soil depth against gravimetric measurements of soil water content. For this purpose, we inserted four access tubes into soil beneath a crop of soybeans and ponded water around four others for 7 days before we began the calibration. With the exception of the 0.15-m depth, it was possible to use a single calibration curve for all depths.

The method of Green and Corey (9) was used to extend the range of the water content-hydraulic conductivity relationships measured by the instantaneous profile method. By this method we calculated the relative hydraulic conductivity of a soil from the water retentivity data. Absolute values can be obtained by matching the relative values with measured hydraulic conductivity at a specific water content. Conductivities at water contents greater than  $0.26 \text{ cm}^3/\text{cm}^3$  were obtained from the instantaneous profile method, and those at water contents less than  $0.26 \text{ cm}^3/\text{cm}^3$  were obtained by the Green and Corey method matched at a water content of  $0.26 \text{ cm}^3/\text{cm}^3$ .

We used the pipette method to determine soil particle fractions. Organic matter was decomposed with 30 percent  $\text{H}_2\text{O}_2$ . Ten ml of dispersing agent (38 g of calgon and 8 g of sodium carbonate dissolved in 1,000 ml of distilled water) was added to 10 g of sample. We separated the sand fraction with a 0.05-mm sieve, and the silt and clay fractions were obtained using an automatic pipette apparatus (5).

**Plant top growth measurements.**—Weekly

throughout the experiment, we collected growth analysis data for each treatment. Before July 15, we collected 10 plants from the nonharvest area of each plot, but after July 15 we collected only 6 plants. We cut each plant at the soil surface, determined height to the terminal bud, and recorded stage of development (6). We removed the leaves and pods from all plants, leaving the petioles with the stems. Leaf areas were measured using a leaf area meter (Li-Cor 3000), then all plant components were oven dried at 60°C and the mass determined.

Leaf area and component mass data were collected weekly during the experiment, but these data gave no indication of the spatial arrangement of the crop canopy. For this purpose, we constructed two 1.0-m  $\times$  1.0-m grids from 0.64-cm diameter steel rod, each with 25 equal-sized compartments. The grids were skewed so that when the uprights were vertical, the 'horizontals' were parallel to the 8 percent slope of the plots. The two grids were then placed at right angles to the rows, 0.5-m apart, dividing the canopy into 25 0.5-  $\times$  0.2-  $\times$  0.2-m compartments. We placed one edge of the grid on the midpoint between two rows and harvested only plants with their bases in the grid area. Because all plots had been thinned to an equal plant population (160,000/ha), eight plants were always present in the grid area. We harvested all plant material (leaves or leaf portions, stems plus petioles, and pods) separately from each grid compartment. We determined leaf area and pod number before all components were oven dried at 60°C and the mass determined. We collected one profile in each replicate on July 31 and again on August 23.

To determine final yield, an area of 24.7 m<sup>2</sup> was harvested from each replicate. The plants were collected by hand and mechanically threshed, and the 100-seed mass was determined from this sample.

At harvest, we collected 10 plants from each replicate for yield component analysis. The pods from each plant were divided into those on branches, the five upper pod-bearing nodes, and the remainder of the main stem. After drying, the pods from each group were put through a single pod thresher so seeds could be counted and their mass determined. Seed size and number per pod did not differ between the upper five nodes and the rest of the main stem, so we combined those data.

**Plant nutrient analysis.**—Before drying, we washed all plant parts collected for growth analysis with distilled water to remove accumulated dust and retained the dried plant parts for nutrient analysis. A wooden frame, 1.0-m<sup>2</sup> and 10-cm high, was placed

in each replicate as a collecting area. We collected abscised leaves and petioles, at least weekly, from 60 days after planting. This shed material was also washed in distilled water to remove dust and soil before being dried at 60°C and the mass determined.

We put the plant components through a grinding mill with a 40-mesh stainless steel screen and sent a subsample to the Ohio Agricultural Research and Development Center, Wooster, Ohio, for nutrient analysis. They determined concentrations of the elements N, P, K, Ca, Mg, Na, Mn, Fe, B, Cu, Zn, and Al. Since dry mass of the plant samples already had been determined, nutrient accumulations per hectare could be calculated.

For the first plant nutrient determination on June 12 (day 28), we combined leaf and stem samples to obtain sufficient material, so only total-plant concentrations were determined. After day 28, the total-plant concentrations were calculated from the individual component concentrations, weighted for the individual component masses.

Shed material, podwalls, and seeds were not analyzed at every sampling time, but usually several samplings were pooled. For shed material, samples number 8 and 9 and samples number 10 to 15 were pooled. We pooled podwalls into three groups: samples 7 to 10 when the very small seeds were not removed, samples 11 and 12, and samples 13 to 15. Seeds were analyzed as two groups only, samples 11 and 12 and samples 13 to 15. Sample 15 was for the irrigated plots only, on September 20. When we pooled samples for analysis, we calculated the accumulations from the individual sample masses.

**Root sample measurements.**—At periodic intervals, we extracted one framed monolith soil sample (15) from each treatment. Because of the large area of plants destroyed and the amount of time required for each sample (2), we obtained no replicates. Soil samples, approximately 0.3 m along the row, 1.0-m wide and 1.8-m deep, were extracted. We forced pins through the block horizontally at 0.075-m depth spacing to 0.45 m, then at 0.15-m increments to 1.8 m. Horizontal spacing of the pins was equal to the vertical spacing. The soil sample was submerged in water and the soil washed away from the pinned root system. We cut the root system into depth sections along the pin lines and cleaned away debris. Root lengths were estimated, using a modification of the Rowse-Phillips instrument (2) for each depth section. We determined mass of the root samples after drying at 60°C.

**Soil water sampling.**—All soil water data were collected gravimetrically. Approximately weekly during



the growth season, we collected five profiles of soil core samples from each plot, three between plants within rows and two midway between rows. Sampling depths were 0 to 0.15 m and 0.15 to 0.30 m and then by 0.305-m depth increments to 2.74 m. We calculated water uptake rates for each soil layer for the nonirrigated plots during periods of little or no rainfall.

Similar calculations could not be done for the irrigated plots because of irrigation during the dry periods. We corrected water uptake rates for water flow between soil layers, using the water content-water potential relationship and the hydraulic conductivity. The mean value of the 1.80- to 2.70-m depth was used in the calculations because this was the depth where most of the drainage and upward movement of water occurred.

**Measurement of evapotranspiration rates.**—Evapotranspiration (ET) was measured using the portable chamber technique of Reicosky and Peters (16) with some minor modifications. Instead of mylar, the chamber used in this study was made of 3.18-mm thick plexiglass for strength and ease of operation. The plexiglass reduced by 8 to 10 percent the light intensity inside the chamber, perhaps reducing ET. However, in comparing treatments, the absolute reduction should be the same. In addition, we mounted the portable chamber on the front end of a hydraulic mast which, in turn, was mounted on the front end of a farm tractor. This enabled the chamber to be mounted away from the front of the tractor to allow for an adequate border around the measurement area. A portable generator was mounted on the back end of the farm tractor to provide a 120 volt (AC) power supply for operating the fans and the strip chart recorders.

We obtained ET measurements with the following general procedure. We selected a measurement area toward the end of each plot to allow tractor access and removed plants that would have been crushed by the chamber walls. The mounted chamber was maneuvered until over the measurement area, and the strip chart recorder was started. When the dry- and wet-bulb temperatures were constant, after about 30 sec, we lowered the chamber and recorded the temperatures for at least 1.5 min. For each measurement, we recorded the time the chamber made contact with the soil, the plot identification, the cloud cover, and the solar radiation.

We recorded the solar radiation using a battery operated Li-Cor Model LI-185 meter with a Model Li-200S pyranometer sensor. At the time of the start of

the measurement, we recorded the radiation and noted any substantial changes. The dry- and wet-bulb temperatures at the time the chamber was lowered and 1 min later were used to calculate ET with a programmable calculator. Since the volume of the chamber and the soil area were constant, we used the psychrometric equation to calculate the rate of change of vapor density and divided that result by the soil area to give ET.

Locations of the individual plots within the main plot area did not permit consecutive measurements across the three replicates. Thus, the measurements were made in a sequence that was the most convenient for moving the portable chamber. Each soil-water treatment was measured as one group, going alternately from 0.25-m to 1.0-m row spacings. This cycle was repeated continuously through the daylight hours.

**Leaf water potential**—We used a pressure chamber (18) to measure the total leaf water potential of recently expanded leaves fully exposed to sunlight. The third or fourth fully unrolled trifoliate below the apex was sampled (7). Three trifoliate per replicate were collected into a plastic box, containing a wet sponge to reduce evaporation. We took pressure chamber readings on the center leaflet only, usually within 2 min of collecting the leaves. We attempted diurnal runs, with measurements taken approximately hourly, weekly during July and August, but rainfall and cloudy weather reduced the number of effective runs.

We measured osmotic potential in conjunction with total leaf water potential five to seven times a day on the various sampling dates, except for July 31 (0 samples) and August 8 (3 samples). At each sampling time, we removed the outer two leaflets of one of the three trifoliate collected for total leaf water potential measurements, wrapped them in polyethylene, and placed them in an air-tight plastic jar, which was then stored on ice. After all plots had been sampled, the osmotic potential samples were placed in a freezer until measured. The sampling process required about 30 min for all 12 samples.

All samples were thawed at 25°C for 20 min before the cellular constituents were expressed and transferred by plastic syringe to a Wescor Model C51 sample chamber. The sample was allowed to equilibrate in the chamber for 3 min and, after 10 sec in the cooling mode, the osmotic potential of the sample was measured in the dew point mode with a Wescor Model HR33 microvolt meter. Diluting the cellular constituents by extra-cellular sap was not accounted for in the recorded values for osmotic potential. It has

been estimated (3) that the extra-cellular sap diluted the cellular constituents of soybean by  $15 \pm$  percent at 100 percent relative water content.

**Data analysis.**—The seasonal plant growth data and the nutrient concentration and accumulation data were analyzed as split-split-plots. Irrigations were main plots, row spacings were subplots, and sampling times were sub-subplots. Because the values obtained at one sampling time were not independent from values obtained at other times, we applied two tests for significance to sampling times and the sampling

time interactions—first using the standard  $n-1$  degrees of freedom for sampling times, and second, using a very conservative test of only 1 degree of freedom (d.f.). If significant differences were found using the conservative 1 d.f., then no doubt existed about the significance, but if  $n-1$  d.f. gave significance and 1 d.f. did not, then we made a subjective judgment.

We analyzed the end-of-season data on yield and yield components as a straight split-plot; that is, without the different sampling times discussed previously.

## DATA SET I. SOILS AND CLIMATE

### Discussion

Soil samples were collected for chemical analysis on July 3 (table 1) and show that variations between

TABLE 1.—SOIL CHEMICAL ANALYSIS OF EXPERIMENTAL SITE FOR DIFFERENT TREATMENTS AND DEPTHS. SOIL COLLECTED JULY 3, 1979

Treatment	Soil depth	pH <sup>1</sup>	Exchangeable + <sup>2</sup> H <sub>2</sub> O soluble cations			CEC <sup>3</sup>	P <sup>4</sup>	Zn <sup>5</sup>	NO <sub>3</sub> -N <sup>6</sup>
			Ca	Mg	K				
m			ppm			me%	ppm		
N25	0-0.15	7.8	9846	784	284	28	10	5.4	57
	0.15-0.30	8.0	9556	816	245	28	6	5.1	48
	0.30-0.60	8.1	9360	1116	232	28	6	4.1	45
	0.60-0.90	8.0	9080	1506	222	30	5	4.0	43
	0.90-1.20	8.1	8616	1565	223	29	6	5.5	43
	1.20-1.80	8.2	8250	1525	240	27	6	5.3	41
1.80-2.70	8.2	8600	1624	269	28	6	6.8	46	
N100	0-0.15	8.0	10346	755	305	30	11	5.4	56
	0.15-0.30	8.1	10520	747	239	30	5	4.2	43
	0.30-0.60	8.2	10023	1043	229	30	4	3.1	36
	0.60-0.90	8.3	9266	1470	234	29	5	5.0	33
	0.90-1.20	8.3	9213	1621	248	30	5	5.0	41
	1.20-1.80	8.4	8983	1559	247	29	5	5.6	34
1.80-2.70	8.3	8730	1562	273	28	6	6.7	41	
I25	0-0.15	7.7	7976	1267	264	24	10	7.6	48
	0.15-0.30	7.7	7336	1308	205	24	5	7.0	42
	0.30-0.60	8.0	7253	1416	200	24	4	5.0	32
	0.60-0.90	8.0	6823	1593	204	24	4	5.0	27
	0.90-1.70	8.1	7036	1650	216	25	4	5.6	23
	1.20-1.80	8.3	6610	1696	208	24	4	5.9	27
1.80-2.70	8.3	6403	1706	232	24	4	5.8	28	
I100	0-0.15	8.0	7513	1251	264	25	10	6.8	42
	0.15-0.30	8.0	7743	1201	210	27	5	5.4	45
	0.30-0.60	8.0	8066	1373	220	23	5	6.5	36
	0.60-0.90	8.1	7486	1476	196	23	3	5.4	30
	0.90-1.20	8.2	7236	1570	194	24	4	5.6	30
	1.20-1.80	8.3	6990	1746	207	24	4	5.1	30
1.80-2.70	8.3	7320	1658	212	25	4	5.6	38	

<sup>1</sup>pH determined in a 1:1 soil-to-water suspension.

<sup>2</sup>Exchangeable cations determined by atomic absorption in 1N ammonium acetate extract.

<sup>3</sup>The cation exchange capacity (CEC) calculated from the exchangeable cation concentrations.

<sup>4</sup>P determined in a Bray No. 1 extract.

<sup>5</sup>Zn determined in a 0.1N HCl extract.

<sup>6</sup>NO<sub>3</sub>-N with a specific ion electrode in a 2:5 soil-to-water suspension.

the treatments were relatively minor. Soil P levels were low (28), but the high pH of the soil reduces the value of the Bray No. 1 extract. Potassium levels were very high (28), and nitrate levels were high probably because of previous soybean crops. Some soil physical parameters are shown in table 2.

Measurements of soil water content and pore water pressure obtained from the *in situ* determination of hydraulic conductivity (table 3) were also used to determine water retentivity (table 4). For any given pore water pressure, these measurements showed the soil held less water than was estimated from the laboratory methods. The differences were almost certainly due to the swelling and more thorough wetting of the laboratory samples. Field determined values are clearly more appropriate for the analysis of field data, and these are shown in table 5 for pore water pressures above -0.1 MPa. Laboratory determined values are shown in brackets beneath the field determined values.

The long-term (1948-78) average rainfall for the site is 735 mm/yr, with an average of 481 mm falling

TABLE 2.—SOIL PHYSICAL PROPERTIES OF THE IDA SILT LOAM, CASTANA, IOWA

Soil depth	Sand 2-.05 mm	Co silt 50-20μ	Fi silt 20-2μ	Clay <2μ	Bulk density	Texture <sup>1</sup>
m	percent				g/cm <sup>3</sup>	
0-.3	9.9	51.9	24.1	14.1	1.29	SiL
.3-.6	9.8	53.3	25.4	11.5	1.19	SiL
.6-.9	9.6	57.7	22.5	10.2	1.24	SiL
.9-1.2	7.8	50.9	27.8	13.5	1.22	SiL
1.2-1.5	12.0	55.4	24.2	8.4	1.24	SiL
1.5-1.8	10.0	51.0	28.4	10.6	1.24	SiL
1.8-2.1	8.6	53.1	28.0	10.3	1.25	SiL
2.1-2.4	12.7	52.4	26.0	8.9	1.24	SiL
2.4-2.7	13.1	54.7	24.1	8.1	1.24	SiL

<sup>1</sup>USDA classification--silt loam.

**TABLE 3.—RELATIONSHIPS BETWEEN SOIL VOLUMETRIC WATER CONTENT CM<sup>3</sup>/CM<sup>3</sup> AND LOG<sub>10</sub> HYDRAULIC CONDUCTIVITY (LOG<sub>10</sub> K—IN CM/DAY) FOR VARIOUS DEPTHS IN THE SOIL PROFILE**

Soil depth	Volumetric Water Content (cm <sup>3</sup> /cm <sup>3</sup> ) <sup>1</sup>															
	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.40
m	cm/day															
0-.3	-7.30	-5.86	-4.68	-3.72	-2.93	-2.27	-1.71	-1.24	-0.85	-0.50	0.14	0.20	0.70	0.86	1.16	-
.3-.6	-6.07	-4.55	-3.36	-2.45	-1.74	-1.19	-0.75	-0.40	-0.10	+0.16	0.64	1.06	1.24	-	-	-
.6-.9	-6.40	-4.64	-3.39	-2.50	-1.79	-1.27	-0.84	-0.48	-0.18	-0.11	0.33	0.57	0.86	1.16	1.46	-
.9-1.2	-8.68	-6.47	-4.84	-3.64	-2.76	-2.09	-1.57	-1.12	-0.71	-0.44	-0.06	0.27	0.56	0.88	1.24	-
1.2-1.5	-7.75	-5.34	-3.79	-2.83	-2.23	-1.82	-1.48	-1.16	-0.86	-0.61	-0.32	0.60	0.41	0.69	1.16	1.86
1.5-1.8	-7.00	-5.07	-3.74	-2.83	-2.20	-1.75	-1.39	-1.07	-0.79	-0.52	-0.24	0.00	0.24	0.46	0.69	-
1.8-2.1	-7.71	-5.59	-4.14	-3.6	-2.49	-2.01	-1.64	-1.32	-1.02	-0.67	-0.27	0.11	0.39	0.68	1.06	-
2.1-2.4	-7.48	-5.50	-4.12	-3.16	-2.50	-2.02	-1.64	-1.32	-1.03	-0.84	-0.54	-0.24	0.06	0.33	0.76	-
2.4-2.7	-8.93	-5.87	-4.03	-2.98	-2.38	-1.97	-1.62	-1.28	-1.00	-0.94	-0.54	-0.24	0.11	0.46	1.00	-

<sup>1</sup> Values above VWC = 0.26 were determined from the instantaneous profile method and those below VWC = 0.26 from the Green and Corey method matched at VWC of 0.26.

in the 5-month period May to September. During 1979, only 344 mm fell during May to September (table 5), but the soybean growing season began with a full soil water profile. May, June, and July all received about half of their average rainfall, but August and September received about average amounts.

Mean monthly temperatures for the growing season were mostly within 1°C of the long term averages. Soil temperatures measured beneath the cropped area (table 6) were consistently cooler than the soil temperatures at the weather station, which were measured below bare soil.

**TABLE 4.—RELATIONSHIPS BETWEEN PORE WATER PRESSURE (MPa) AND SOIL VOLUMETRIC WATER CONTENT (CM<sup>3</sup>/CM<sup>3</sup>) FOR VARIOUS DEPTHS IN THE PROFILE**

Soil depth	Pore Water Pressure <sup>1</sup>											
	-1.0x10 <sup>-3</sup>	-2.0x10 <sup>-3</sup>	-4.0x10 <sup>-3</sup>	-8.0x10 <sup>-3</sup>	-0.016	-0.033	-0.050	-0.1	-0.2	-0.4	-0.8	-1.5
m	cm <sup>3</sup> /cm <sup>3</sup>											
0-.3		0.360 (0.485)	0.348 (0.470)	0.332 (0.453)	0.308 (0.360)	0.278 (0.290)	0.258 (0.258)					
.3-.6			0.368 (0.491)	0.338 (0.410)	0.283 (0.311)	0.215 (0.228)	0.188 (0.188)					
.6-.9			0.375 (0.493)	0.347 (0.441)	0.300 (0.376)	0.225 (0.254)	0.192 (0.211)					
.9-1.2		0.410 (0.507)	0.385 (0.477)	0.358 (0.432)	0.317 (0.375)	0.265 (0.290)	0.242 (0.254)					
1.2-1.5			0.395 (0.485)	0.375 (0.428)	0.332 (0.390)	0.270 (0.283)	0.247 (0.247)					
1.5-1.8			0.411 (0.542)	0.395 (0.462)	0.363 (0.413)	0.270 (0.291)	0.227 (0.241)					
1.8-2.1			0.404 (0.559)	0.390 (0.474)	0.353 (0.411)	0.285 (0.293)	0.267 (0.267)					
2.1-2.4			0.409 (0.535)	0.387 (0.444)	0.355 (0.426)	0.295 (0.317)	0.267 (0.267)					
2.4-2.7			0.405 (0.562)	0.382 (0.457)	0.353 (0.428)	0.285 (0.316)	0.245 (0.270)					

<sup>1</sup> In situ field measurements obtained for pore water pressures between -0.05 and 2.0 x 10<sup>-3</sup> MPa. Laboratory measurements (shown in parentheses) obtained for full range of pore water pressures presented.

Text continues on page 11.



TABLE 5.—CLIMATIC DATA FOR CASTANA, IOWA. ALL MEASUREMENTS, EXCEPT MAX AND MIN, TAKEN AT 5 P.M.

Date	Temperature		Soil Temperature -----depth in cm-----					Wind Run	Class A Pan Evap.	Rain	Radiation
	Max	Min	5.7	10.2	20.3	50.8	101.6				
May 1979	-----°C-----							km/day	mm	mm	Ly/day
1	17.8	1.1	11.1	8.9	3.3	6.1	5.6	174	2.8	T	-
2	16.1	7.8	7.8	7.2	4.4	6.7	5.6	166	3.6	31.0	-
3	12.2	0.0	13.9	11.1	3.9	6.7	5.6	208	3.3	-	-
4	18.3	0.0	19.4	15.0	5.6	6.7	6.1	82	4.0	-	-
5	23.3	10.6	15.6	14.4	7.8	7.8	6.1	280	9.5	-	-
6	27.2	11.7	20.0	20.6	10.6	8.3	8.3	282	7.3	-	-
7	27.8	13.3	22.8	19.4	10.6	8.9	6.7	163	5.8	-	-
8	22.8	11.1	10.6	10.6	7.8	9.4	7.2	149	4.0	-	-
9	18.3	8.3	13.9	12.8	7.2	9.4	7.2	152	1.8	7.6	-
10	11.1	3.9	7.8	7.2	5.0	9.4	7.8	162	0.3	-	-
11	11.7	0.6	16.1	11.7	5.0	8.3	7.8	176	2.0	-	-
12	18.9	0.6	14.4	12.8	6.1	8.3	7.8	90	2.3	T	-
13	21.1	3.3	18.9	16.1	7.8	8.3	7.8	77	3.0	T	-
14	21.1	6.7	18.9	16.7	8.9	8.9	7.8	80	5.0	T	-
15	22.8	6.7	24.4	20.0	9.4	9.4	7.8	48	4.3	-	-
16	26.1	9.4	25.0	20.0	10.6	10.0	8.3	198	6.5	-	-
17	30.6	13.3	29.4	25.0	13.3	11.1	8.3	310	13.2	-	-
18	28.9	12.2	13.3	13.3	11.1	11.7	8.9	194	4.0	10.4	-
19	21.7	8.3	18.9	19.4	11.1	11.7	8.9	48	2.0	-	-
20	20.0	10.6	17.2	17.2	11.7	12.2	9.4	85	5.0	-	-
21	18.9	3.9	22.8	18.3	10.0	12.2	10.0	66	4.3	-	-
22	25.6	10.0	23.9	20.0	11.7	12.2	10.0	149	6.8	T	-
23	23.9	8.3	19.4	18.3	12.2	12.8	10.6	202	9.8	-	-
24	20.0	4.4	22.2	18.9	12.2	12.8	10.6	38	4.0	-	-
25	24.4	5.6	25.6	21.7	12.2	12.8	10.6	62	4.3	-	-
26	24.4	12.2	20.0	18.3	12.8	13.3	11.1	98	7.3	7.6	-
27	24.4	10.6	27.8	22.8	12.8	13.3	11.1	46	4.0	-	-
28	30.0	11.7	28.3	23.9	13.9	13.9	11.1	91	6.3	-	-
29	30.6	16.7	31.7	27.2	16.1	15.0	11.7	112	8.0	-	-
30	30.0	13.3	15.0	15.6	13.3	15.6	11.7	101	5.8	T	-
31	18.9	7.2	23.3	18.9	11.7	14.4	12.2	150	3.0	4.6	-
Means or Totals	22.2	7.8	19.3	16.9	9.8	10.6	8.7	4142	154.7	61.6	-
June 1979											
1	23.9	5.0	18.3	17.8	13.3	14.4	12.8	85	5.8	-	-
2	27.8	8.3	27.8	24.4	14.4	14.4	12.8	37	4.8	-	-
3	30.0	12.2	29.4	25.6	16.1	15.6	12.8	66	7.9	-	-
4	30.0	16.1	30.0	26.1	16.1	16.1	12.8	86	7.4	6.9	-
5	29.4	13.3	32.8	28.3	17.2	16.7	13.3	69	7.6	-	-
6	30.0	19.4	30.6	28.3	18.9	17.2	13.9	210	12.4	-	-
7	28.9	17.2	27.8	-	18.9	18.3	13.9	117	6.1	T	-
8	26.7	11.7	14.4	15.0	13.9	17.8	13.9	149	3.6	4.3	-
9	15.0	11.1	14.4	14.4	12.2	16.7	14.4	53	-	18.3	-
10	22.8	8.3	21.1	18.9	13.3	15.6	14.4	141	7.1	4.1	-
11	28.3	11.7	28.9	23.9	15.0	15.6	14.4	58	6.1	-	718
12	32.2	15.0	32.2	27.8	17.2	16.7	14.4	85	7.1	-	605
13	32.8	15.6	32.2	28.3	18.3	17.2	14.4	122	9.1	-	691
14	35.0	16.1	31.1	27.2	19.4	18.3	15.0	192	9.9	-	623
15	34.4	18.3	31.1	28.3	20.0	18.9	15.0	192	8.9	-	576
16	30.6	17.2	24.4	24.4	20.0	19.4	15.6	128	8.1	T	-
17	19.4	10.6	19.4	18.3	15.6	19.4	15.6	106	4.6	3.8	275
18	23.3	13.3	18.9	17.8	14.4	18.3	16.1	170	2.5	3.0	153
19	29.4	18.3	26.1	23.3	17.2	17.8	16.1	235	4.8	T	481
20	27.8	12.2	24.4	21.7	15.6	17.8	16.1	197	9.7	19.1	482
21	31.7	13.3	-	28.9	17.8	17.8	16.1	61	6.4	-	678
22	31.7	15.6	25.0	22.8	17.8	18.9	16.1	64	6.4	-	415
23	23.9	13.9	25.6	21.7	16.1	18.9	16.1	93	4.1	-	307
24	23.3	10.6	28.9	25.6	17.8	18.3	16.1	54	9.9	-	641
25	26.1	12.8	31.1	27.2	18.3	18.3	16.1	88	0.8	-	610
26	30.6	16.1	32.8	28.3	19.4	18.9	16.1	150	6.4	-	616
27	30.6	18.9	33.3	29.4	20.0	19.4	16.7	102	6.1	1.3	567
28	32.2	19.4	35.0	30.6	20.6	20.0	16.7	48	5.3	-	541
29	31.7	16.7	32.2	28.9	21.1	20.6	17.2	112	11.7	-	667
30	31.7	11.7	31.1	28.9	21.7	20.6	17.2	27	7.1	-	706
Means or Totals	28.4	14.0	27.3	24.6	17.3	17.8	15.1	3294	204.7	60.7	-



TABLE 5.—CLIMATIC DATA FOR CASTANA, IOWA. ALL MEASUREMENTS, EXCEPT MAX AND MIN, TAKEN AT 5 P.M.—CONTINUED

Date	Temperature		Soil Temperature					Wind Run	Class A Pan Evap.	Rain	Radiation
	Max	Min	depth in cm								
			5.7	10.2	20.3	50.8	101.6				
°C								km/day	mm	mm	Ly/day
July 1979											
1	28.3	16.1	31.7	27.8	20.0	20.6	17.8	86	6.9		500
2	30.6	17.2	31.1	27.2	20.0	20.6	17.8	114	6.6		539
3	34.4	21.7	37.2	32.2	22.2	21.1	17.8	70	5.8		683
4	34.4	18.9	21.1	21.1	20.0	22.2	17.8	77	6.1		212
5	24.4	15.0	25.0	23.9	18.9	20.6	17.8	141	4.6		588
6	22.8	14.4	20.0	19.4	17.2	20.6	18.3	90	3.8	T	322
7	23.3	15.6	23.3	22.2	17.2	19.4	18.3	83	3.0		289
8	26.1	17.8	26.7	24.4	18.3	19.4	18.3	93	3.6		141
9	30.0	14.4	33.3	28.9	19.4	20.0	18.3	40	4.6		-
10	32.8	16.1	35.6	31.1	20.6	20.6	18.3	30	5.6		-
11	32.8	16.7	32.2	29.4	22.8	21.1	18.3	85	9.6		606
12	32.2	21.7	33.9	30.0	22.2	21.7	18.3	112	6.4	T	570
13	34.4	22.2	33.9	31.1	23.3	22.2	18.3	114	8.4	3.8	579
14	33.3	17.8	32.8	30.6	23.3	22.2	18.9	66	7.1		655
15	31.1	18.3	32.8	30.0	22.8	22.2	18.9	74	3.6	1.8	646
16	28.9	18.3	29.4	27.2	21.1	22.2	18.9	40	5.8	T	536
17	26.7	13.3	33.9	29.4	20.6	21.7	18.9	40	6.6		601
18	27.2	8.9	32.8	28.9	20.6	21.7	18.9	34	6.1		623
19	28.9	13.3	23.9	23.9	21.7	21.7	18.9	88	9.1		627
20	30.6	16.7	35.6	30.6	22.2	21.7	19.4	74	7.4		602
21	31.7	19.4	30.0	28.3	23.3	22.2	19.4	163	12.7		549
22	28.9	17.8	30.0	27.2	21.1	22.8	19.4	99	1.3	13.0	479
23	30.0	21.1	31.1	28.3	21.1	22.2	19.4	149	5.1		481
24	28.9	20.0	31.7	28.3	21.1	22.2	19.4	91	2.3	T	388
25	30.0	18.9	34.4	30.6	22.8	22.2	19.4	43	4.8	T	532
26	30.6	15.6	35.0	31.1	22.8	22.2	19.4	37	5.8		538
27	30.6	17.2	29.4	28.3	20.6	22.8	19.4	40	1.0		380
28	26.7	17.8	28.3	27.2	19.4	22.2	19.4	56	3.8	T	353
29	28.9	18.3	24.4	23.9	19.4	22.2	20.0	110	4.6	2.0	299
30	29.4	17.2	30.0	28.3	20.0	22.2	20.0	118	9.4	12.4	563
31	28.3	17.2	26.1	25.0	18.9	21.7	20.0	56	5.3		399
Means or Totals	29.6	17.3	30.2	27.6	20.8	21.6	18.8	2512	176.8	33.0	
August 1979											
1	27.2	14.4	31.7	30.6	20.0	21.7	20.0	37	4.1		581
2	30.0	16.1	32.2	30.6	20.6	21.7	20.0	86	6.1		479
3	32.2	17.8	35.0	33.3	22.2	22.2	20.0	59	5.6		598
4	34.4	22.8	30.6	30.0	24.4	23.3	20.0	194	12.2		634
5	32.2	23.3	35.6	33.9	24.4	23.9	20.0	96	6.1		573
6	35.6	20.6	35.6	33.9	23.9	23.9	20.0	101	10.7		608
7	36.1	23.3	36.7	35.0	23.9	24.4	20.6	150	6.1		600
8	35.6	24.4	28.3	27.2	22.2	24.4	20.6	106	6.8	T	284
9	33.9	23.3	33.3	31.7	22.8	24.4	20.6	133	6.1		496
10	33.3	16.1	31.7	30.0	21.7	24.4	21.1	117	8.6		525
11	25.0	11.1	27.8	27.2	21.1	24.4	21.1	59	8.1		622
12	27.8	13.3	28.9	27.2	20.0	23.3	21.1	203	8.1		505
13	26.1	16.1	19.4	18.9	17.8	22.8	21.1	45	2.5	2.3	141
14	18.9	11.1	23.3	22.2	16.1	21.7	20.6	40	2.0		300
15	18.9	11.1	17.2	16.7	14.4	20.6	20.6	-	-	0.5	184
16	23.9	13.3	23.9	22.8	15.0	20.0	20.6	160	3.3		302
17	32.8	20.0	27.8	26.7	20.6	20.6	20.0	200	5.6		496
18	28.3	20.0	25.6	25.0	19.4	21.1	20.0	51	3.3	T	187
19	31.7	17.8	30.6	28.9	21.1	21.7	20.0	130	7.1		543
20	31.7	17.2	32.8	30.6	21.1	22.2	20.0	64	6.1		565
21	29.4	17.2	21.7	20.6	18.3	22.2	20.0	66	5.3	22.4	191
22	27.2	16.7	24.4	23.3	18.3	21.1	20.0	69	5.3	18.8	354
23	24.4	15.6	23.3	21.7	17.2	21.1	20.0	85	5.6	1.3	487
24	27.8	11.1	26.1	23.3	16.1	20.6	20.0	30	4.6		-
25	27.8	15.6	23.3	22.8	17.8	20.6	20.0	59	6.1	4.1	-
26	23.3	16.7	-	-	-	-	-	42	-	36.8	-
27	22.8	12.8	21.7	20.0	15.0	20.6	20.0	26	1.8	0.5	-
28	27.8	14.4	22.8	21.7	15.6	19.4	19.4	110	2.0	T	-
29	30.0	15.0	27.8	24.4	17.2	20.0	19.4	38	4.1		-
30	30.6	17.2	28.9	26.7	18.3	20.6	19.4	70	5.8		-
31	31.1	21.1	29.4	27.2	19.4	21.1	19.4	171	6.6		-
Means or Totals	29.0	17.0	27.9	26.4	19.6	22.0	20.2	2797	177.5	86.6	

TABLE 5.—CLIMATIC DATA FOR CASTANA, IOWA. ALL MEASUREMENTS, EXCEPT MAX AND MIN, TAKEN AT 5 P.M.—CONTINUED

Date	Temperature		Soil Temperature					Wind Run	Class A Pan Evap.	Rain	Radiation
	Max	Min	5.7	10.2	20.3	50.8	101.6				
September 1979	°C							km/day	mm	mm	Ly/day
1	30.0	16.1	22.8	22.2	18.3	21.1	20.0	210	15.7	54.4	-
2	28.9	15.0	24.4	23.3	18.9	21.1	20.0	29	4.6	-	-
3	28.9	16.7	22.8	22.2	18.3	21.1	20.0	80	5.6	-	-
4	29.4	18.3	25.0	23.9	19.4	21.7	20.0	162	6.6	-	-
5	32.2	18.9	31.1	28.3	19.4	21.7	20.0	104	4.1	-	-
6	23.3	14.4	21.7	21.1	18.3	21.7	20.0	48	12.2	17.5	-
7	22.2	12.8	23.3	21.7	16.1	21.1	20.0	56	2.0	-	-
8	25.0	13.3	20.6	20.0	16.7	20.6	20.6	130	6.9	7.9	-
9	28.3	16.1	22.2	21.1	17.2	20.6	20.6	187	5.8	-	-
10	30.6	18.9	28.3	25.6	17.8	20.6	20.0	158	6.1	-	-
11	30.0	16.1	22.8	21.7	17.2	21.1	20.0	98	5.1	-	-
12	21.7	13.3	16.1	15.6	14.4	20.6	20.0	48	2.3	22.1	-
13	18.9	7.2	18.3	16.7	13.3	19.4	20.0	86	3.0	-	-
14	17.2	6.1	16.7	15.6	12.2	18.3	20.0	48	2.8	-	-
15	23.3	6.1	20.0	18.9	12.8	17.8	19.4	42	2.8	-	-
16	25.0	8.3	22.8	20.0	13.3	17.8	19.4	96	4.6	-	-
17	26.7	9.4	19.4	18.3	14.4	17.8	18.9	149	3.6	-	-
18	22.8	11.7	21.1	20.0	14.4	17.8	18.9	61	7.9	-	-
19	23.3	7.2	24.4	21.1	13.9	17.8	18.9	46	3.0	-	-
20	23.3	12.8	23.9	21.1	13.9	17.8	18.3	96	4.3	-	-
21	21.7	4.4	21.1	19.4	12.8	17.8	18.3	48	4.6	-	-
22	20.6	5.0	18.9	17.8	12.8	17.2	18.3	91	5.6	-	-
23	25.0	11.1	20.0	18.9	13.3	17.2	18.3	171	5.1	-	-
24	25.6	12.2	23.3	21.7	13.9	17.2	17.8	110	3.8	-	-
25	27.8	10.0	25.0	22.8	14.4	17.8	17.8	32	3.6	-	-
26	26.7	11.1	22.8	20.6	14.4	17.8	17.8	109	6.6	-	-
27	28.3	15.6	24.4	22.2	15.0	17.8	17.8	142	5.3	-	-
28	27.2	12.2	21.1	20.0	15.0	18.3	18.3	86	5.3	-	-
29	27.8	7.2	22.2	21.1	14.0	18.3	18.3	30	5.1	-	-
30	26.7	10.6	22.8	21.1	15.6	18.3	18.3	54	1.5	-	-
Means or Totals	25.9	11.9	22.3	20.8	15.4	19.2	19.2	2808	155.4	101.9	-

TABLE 6.—SOIL TEMPERATURE AS A DEPTH AND TIME FUNCTION. TEMPERATURE PROBES PLACED IN THE SECOND REPLICATE OF EACH TREATMENT

Soil depth	June 12	June 20	June 26	July 3	July 11	July 18	July 25	Aug. 2	Aug. 16	Aug. 28
m	°C									
0.25-m row width, nonirrigated (N25)										
0.5	16.1	18.8	18.8	21.1	20.4	20.5	20.8	20.1	18.6	19.0
1.0	13.7	15.7	15.5	17.0	17.2	18.0	18.1	18.1	18.2	17.8
1.5	11.3	12.6	13.2	14.1	14.9	15.4	15.7	16.0	16.3	16.3
2.0	9.6	10.4	11.1	11.8	12.7	13.4	14.1	14.5	14.6	14.8
2.5	8.5	9.7	9.9	10.5	11.2	11.8	12.3	13.0	13.3	13.6
3.0	-	8.5	8.9	9.4	10.0	10.5	11.1	11.6	12.1	13.2
0.25-m row width, irrigated (I25)										
0.5	16.9	18.9	19.8	20.7	20.0	20.7	20.2	19.6	18.0	(1)
1.0	14.6	16.8	16.1	17.3	17.4	18.7	18.8	18.4	18.4	(1)
1.5	12.3	13.2	13.6	14.5	15.0	15.8	16.0	16.2	16.9	(1)
2.0	10.3	11.2	11.8	12.5	13.4	14.0	14.4	14.8	15.4	(1)
2.5	-	9.6	9.7	10.5	11.5	12.2	13.1	13.8	13.4	(1)
3.0	-	8.2	8.6	9.2	9.8	10.3	11.3	11.5	11.8	(1)
1.0-m row width, nonirrigated (N100)										
0.5	16.6	18.4	19.4	21.9	21.5	21.5	21.3	20.2	18.6	18.7
1.0	14.1	15.8	15.8	17.5	17.8	18.6	19.0	18.6	18.6	19.2
1.5	11.4	12.7	13.2	14.3	15.2	15.9	16.2	16.5	16.8	17.4
2.0	9.4	10.8	11.1	11.8	12.8	13.4	14.4	14.8	15.2	17.4
2.5	9.1	9.6	9.9	10.5	11.3	11.9	12.5	13.1	13.6	14.1
3.0	-	8.6	8.6	9.1	9.7	10.3	11.3	12.2	12.0	13.4
1.0-m row width, irrigated (I100)										
0.5	16.8	18.5	19.4	20.9	20.3	21.2	21.0	20.6	18.2	(1)
1.0	14.4	15.8	16.1	17.2	17.3	18.7	18.3	18.3	18.3	(1)
1.5	12.2	13.4	13.9	14.7	15.5	16.7	16.8	17.1	17.2	(1)
2.0	10.4	11.4	11.9	12.6	13.4	14.2	15.0	15.3	15.6	(1)
2.5	9.4	10.1	10.5	11.1	12.2	13.3	13.4	13.7	14.2	(1)
3.0	-	8.7	8.9	9.4	10.4	12.0	12.8	13.0	13.7	(1)

<sup>1</sup>These temperature probes located at edge of plot due to plant root sampling.

## DATA SET II. CROP GROWTH

### Discussion

Fifty percent emergence occurred about May 27 (table 7); however, the planting date (May 15) is used as the zero date in this report. The symbols N25, N100, I25, and I100 (for nonirrigated 0.25-m rows, nonirrigated 1.0-m rows, irrigated 0.25-m rows, and irrigated 1.0-m rows, respectively) are used extensively in this report.

The last sample for crop growth and development was collected on September 11 (day 119) for the nonirrigated plots. Because of delayed maturity, one extra sampling on September 20 (day 128) was carried out in the irrigated plots.

In general, irrigation increased plant height, leaf area, and biomass production and slowed both vegetative and reproductive development. Planting soybeans in 1.0-m rows rather than 0.25-m rows increased plant height, biomass production and pod number, and speeded reproductive development (table 8). Leaf areas did not differ significantly between row spacings, but the more even canopy distribution of the narrow rows (tables 9 and 10) resulted in greater radiation interception (fig. 3).

Shibles and Weber (21) also report increased interception in narrow rows but found that increased dry matter production resulted from the increased radiation (20). Increased dry matter production did not occur in this study; in fact, total biomass production estimates for N25, N100, I25, and I100 were 935, 1025, 1260, and 1408 g/m<sup>2</sup>. Shed leaves and peti-

oles, on-plant material and roots were included in the biomass estimates.

With the significant increases in biomass production caused by irrigation and wide row spacing, the final seed yield results in table 11 are somewhat surprising but are consistent with several other experiments (8, 21, 24). The 0.25-m row spacing significantly outyielded the 1.0-m row spacing, and irrigation had no significant effect on yield except to reduce seed size. Shibles and Weber (21) concluded that soybean yields were not well correlated with total dry matter production or dry matter production rates during pod fill. The data presented here are consistent with that conclusion. Also, yield in this experiment was not well correlated with plant height, number of vegetative nodes, or the length of the vegetative stage. We concluded that none of these responses to row spacing and irrigation was the reason that the 0.25-m row spacing soybeans outyielded the 1.0-m rows.

The statistical analysis data in table 12 show that the 1.0-m row spacing plots produced significantly more pods than the 0.25-m rows. The irrigation effect was not significant because of the significant Time x Irrigation interaction. That is, the irrigated plots produced more pods than the nonirrigated plots, but pod development was delayed. As late as September 11 (day 119), the 1.0-m rows had 9 percent more pods than the 0.25-m rows, and the irrigated plots had 17 percent more pods than the nonirrigated ones.

TABLE 7.—EMERGENCE DATA FOR SOYBEANS PLANTED MAY 15 IN 1.0-M AND 0.25-M ROWS

DATE	1.0-M ROWS		0.25-M ROWS	
	REP. 1	REP. 2	REP. 1	REP. 2
-----PERCENT-----				
MAY				
21	0.5	0.0	0.0	0.0
22	3.7	0.0	0.0	0.0
23	18.2	2.8	2.1	3.9
24	28.0	12.0	7.2	8.9
25	31.3	15.6	13.1	12.8
26	36.4	28.4	32.2	26.2
27	43.5	40.4	56.7	45.2
28	68.2	56.0	76.7	60.0
29	85.0	87.2	95.5	83.9
30	89.7	88.8	96.4	86.6
31	91.6	90.4	97.6	88.2
JUNE				
1	95.8	92.0	98.5	97.4
2	97.7	97.2	99.4	99.3
3	99.1	98.0	99.4	99.3
4	100.0	98.8	100.0	100.0
5	—	100.0	—	—

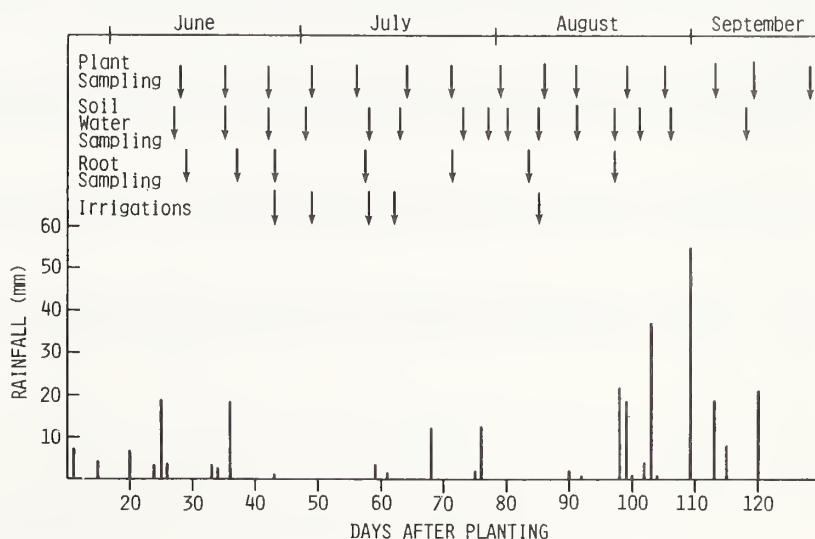


FIGURE 1.—Time course of sampling events, irrigations, and rainfall amounts for the soybean experiment of Castano, Iowa, 1979.

Text continues on page 18.

TABLE 8.—DRY MATTER PRODUCTION AND PLANT DEVELOPMENT DATA FOR SOYBEANS GROWN DURING 1979. STAGE OF DEVELOPMENT ESTIMATES BY FEHR AND CAVINESS METHOD (1977). TOTAL DM DOES NOT INCLUDE SHED MATERIAL

DAYS AFTER PLANTING	REP	STAGE OF DEVELOPMENT			PLANT HEIGHT (CM)	LAI	PLANT MASS 1G/M2					POD NUMBER PER M2	
		VEG	REPRO	REPRO			LEAF	STEM PLUS PETIOLE	POD WALL	BEAN	TOTAL		SHED LEAF
NONIRRIGATED IN 0.25-M ROWS (N25)													
28	1	1.6	0.0	0.0	8.30	0.12	5.6	2.1	-	-	-	7.7	-
28	2	1.7	0.0	0.0	7.90	0.15	6.9	2.1	-	-	-	9.0	-
28	3	1.6	0.0	0.0	8.70	0.18	8.5	3.2	-	-	-	11.7	-
35	1	2.8	0.0	0.0	9.90	0.23	11.4	5.6	-	-	-	17.0	-
35	2	3.0	0.0	0.0	11.60	0.22	10.2	5.9	-	-	-	22.2	-
35	3	3.3	0.0	0.0	11.90	0.33	15.5	6.9	-	-	-	22.4	-
42	1	5.2	0.0	0.0	15.50	0.49	23.2	10.7	-	-	-	33.9	-
42	2	5.8	0.0	0.0	17.40	0.73	29.9	15.8	-	-	-	45.8	-
42	3	5.9	0.0	0.0	16.80	0.69	29.6	14.6	-	-	-	44.2	-
49	1	7.3	0.0	0.0	20.50	1.33	53.3	30.4	-	-	-	83.7	-
49	2	7.1	0.0	0.0	21.50	1.74	61.4	36.3	-	-	-	97.8	-
49	3	7.0	0.0	0.0	22.00	1.54	52.2	33.3	-	-	-	85.4	-
56	1	9.3	0.1	0.1	29.20	2.47	80.0	65.3	-	-	-	145.3	-
56	2	8.6	0.2	0.2	27.10	2.54	78.1	57.8	-	-	-	135.8	-
56	3	8.8	0.0	0.0	29.30	2.42	75.7	62.9	-	-	-	138.6	-
64	1	11.2	2.0	2.0	40.10	4.70	164.3	152.0	-	-	-	316.3	0.5
64	2	10.5	2.0	2.0	35.00	3.69	126.1	118.9	-	-	-	245.1	0.8
64	3	11.0	2.0	2.0	42.90	3.31	111.5	119.5	-	-	-	231.0	0.8
71	1	12.2	2.0	2.0	40.00	3.67	143.8	141.6	0.3	-	-	285.6	0.2
71	2	11.3	2.2	2.2	45.00	4.66	149.6	158.7	0.3	-	-	308.6	0.1
71	3	12.7	2.3	2.3	48.00	3.99	128.5	155.5	0.5	-	-	284.0	0.1
79	1	15.2	3.0	3.0	68.00	4.28	183.2	236.8	7.2	-	-	427.3	1.3
79	2	15.5	3.3	3.3	70.00	4.24	168.8	213.6	10.4	-	-	392.8	5.6
79	3	15.0	3.3	3.3	70.00	4.81	141.6	179.0	7.7	-	-	328.3	9.2
86	1	17.7	4.8	4.8	83.00	5.30	199.2	296.3	67.5	-	-	563.0	4.3
86	2	17.3	4.9	4.9	79.00	5.60	179.2	273.2	50.1	-	-	503.3	2.9
86	3	16.3	4.2	4.2	79.00	5.64	202.7	298.2	62.9	-	-	563.8	2.6
91	1	17.3	4.8	4.8	74.80	4.16	171.5	252.6	81.1	-	-	505.1	7.7
91	2	17.2	5.0	5.0	77.30	6.47	250.7	386.7	130.7	-	-	768.1	1.9
91	3	17.3	5.0	5.0	76.80	4.17	147.5	243.2	78.7	-	-	469.4	6.8
99	1	19.5	5.5	5.5	84.00	3.63	203.2	300.0	137.4	81.1	-	721.7	12.1
99	2	17.5	5.0	5.0	79.20	3.47	111.5	186.2	71.5	50.1	-	419.3	11.0
99	3	19.3	5.0	5.0	85.30	3.77	151.5	296.6	104.8	78.9	-	631.8	13.0
105	1	20.0	6.0	6.0	82.80	5.20	191.0	373.1	140.3	156.3	-	860.6	12.1
105	2	18.7	6.0	6.0	83.50	3.77	138.2	251.5	97.3	116.8	-	603.8	13.6
105	3	18.7	6.0	6.0	87.80	3.55	130.7	257.6	94.9	110.7	-	603.0	13.4
113	1	16.2	6.0	6.0	86.00	4.86	211.8	337.9	133.3	224.6	-	907.6	11.7
113	2	17.0	6.0	6.0	84.00	3.40	149.9	270.2	114.1	224.6	-	750.8	17.7
113	3	18.2	6.0	6.0	86.00	3.06	130.1	267.2	97.6	198.4	-	693.4	8.3
119	1	18.0	6.0	6.0	85.50	2.56	110.9	302.2	112.8	296.0	-	822.0	38.9
119	2	16.8	6.3	6.3	81.30	1.51	61.9	213.3	97.1	239.2	-	610.3	42.9
119	3	17.3	6.0	6.0	86.60	1.71	74.9	250.7	109.6	257.9	-	693.2	38.3
NONIRRIGATED IN 1.0-M ROWS (N100)													
28	1	1.7	0.0	0.0	8.00	0.13	6.2	2.2	-	-	-	8.5	-
28	2	1.4	0.0	0.0	7.60	0.13	6.2	2.1	-	-	-	8.3	-
28	3	1.4	0.0	0.0	8.60	0.12	5.4	2.1	-	-	-	7.5	-
35	1	3.4	0.0	0.0	11.60	0.26	11.7	6.1	-	-	-	17.8	-
35	2	3.7	0.0	0.0	12.80	0.30	13.4	7.2	-	-	-	20.6	-
35	3	3.5	0.0	0.0	13.40	0.33	14.9	7.2	-	-	-	22.1	-
42	1	5.4	0.0	0.0	17.20	0.64	26.9	13.8	-	-	-	40.6	-
42	2	4.8	0.0	0.0	16.90	0.55	24.4	11.8	-	-	-	37.3	-
42	3	5.3	0.0	0.0	17.60	0.62	25.1	12.8	-	-	-	37.9	-
49	1	7.3	0.0	0.0	26.50	1.61	59.0	37.3	-	-	-	96.3	-
49	2	7.2	0.0	0.0	25.50	1.55	56.2	34.3	-	-	-	91.0	-
49	3	7.3	0.0	0.0	28.10	1.34	43.4	31.0	-	-	-	74.4	-
56	1	9.0	0.5	0.5	36.00	2.67	86.7	53.6	-	-	-	140.3	-
56	2	9.2	0.3	0.3	37.10	2.49	71.2	62.2	-	-	-	133.4	-
56	3	8.9	0.8	0.8	39.50	2.28	68.2	61.1	-	-	-	130.2	-
64	1	12.5	2.0	2.0	47.20	3.84	143.0	130.9	-	-	-	273.9	2.3
64	2	11.2	2.0	2.0	44.30	4.01	124.8	110.7	-	-	-	235.5	7.1
64	3	11.0	2.0	2.0	53.00	3.52	111.5	110.7	-	-	-	231.2	5.4



TABLE 8.—DRY MATTER PRODUCTION AND PLANT DEVELOPMENT DATA FOR SOYBEANS GROWN DURING 1979. STAGE OF DEVELOPMENT ESTIMATES BY FEHR AND CAVINESS METHOD (1977). TOTAL DM DOES NOT INCLUDE SHED MATERIAL—CONTINUED

DAYS AFTER PLANTING	REP	STAGE OF DEVELOPMENT			PLANT HEIGHT (CM)	LA1	PLANT MASS (G/M2)							POD NUMBER PER M2
		VEG	REPRD	STEM PLUS PETIOLE			LEAF	STEM PLUS PETIOLE	POD WALL	BEAN	TOTAL	SHED LEAF	SHED PETIOLE	
NONIRRIGATED IN 1.0-M ROWS (N100)---CONTINUED														
71	1	14.0	2.8	205.4	60.00	5.84	205.4	220.3	1.1	-	426.7	0.9	0.1	485.4
71	2	14.2	2.8	188.0	63.00	6.26	188.0	236.0	2.1	-	426.2	1.2	0.1	464.1
71	3	13.3	2.8	188.0	66.00	4.58	188.3	188.0	2.1	-	329.6	2.6	0.3	421.4
79	1	16.3	3.3	247.5	73.00	6.64	247.5	331.8	18.4	-	597.7	8.6	0.6	485.4
79	2	16.3	3.5	209.9	79.00	4.16	209.9	307.2	18.1	-	535.3	9.1	1.1	464.1
79	3	15.2	3.7	186.7	81.00	4.38	186.7	252.6	16.0	-	455.3	10.2	1.1	421.4
86	1	17.5	5.0	185.9	91.00	4.62	185.9	284.0	72.0	-	541.9	6.1	1.8	903.4
86	2	18.3	5.0	268.6	86.00	7.56	268.6	416.3	97.1	-	782.0	2.6	1.8	1342.5
86	3	18.3	4.2	249.4	81.00	6.90	249.4	363.0	87.5	-	699.8	2.6	2.9	1154.9
91	1	19.0	5.0	174.4	84.50	4.55	174.4	271.0	84.8	-	530.2	8.6	1.9	746.8
91	2	17.3	4.8	185.4	84.30	4.96	185.4	308.0	103.5	-	596.9	6.7	0.9	1008.1
91	3	18.5	5.0	201.1	92.00	5.20	201.1	321.1	113.1	-	635.3	5.1	0.4	1010.8
99	1	17.8	5.3	216.0	77.70	4.39	216.0	358.2	140.3	105.6	820.1	10.6	4.6	1304.2
99	2	20.0	5.2	186.4	92.50	3.54	186.4	305.1	135.0	95.5	722.0	9.1	0.9	1210.8
99	3	17.8	5.2	121.6	91.20	3.14	121.6	239.0	86.7	55.5	502.7	13.7	1.4	1010.8
105	1	20.8	6.0	197.9	84.20	4.65	197.9	329.4	112.8	107.7	747.8	14.2	5.5	1026.8
105	2	19.8	6.0	220.0	92.20	5.04	220.0	352.8	128.0	142.4	843.3	11.8	5.9	1050.8
105	3	18.7	6.0	148.6	94.50	3.52	148.6	266.7	105.9	120.3	641.4	13.6	5.6	797.4
113	1	18.8	6.0	199.8	86.00	4.33	199.8	386.4	149.1	278.2	1013.5	8.6	5.8	1173.5
113	2	17.5	6.0	154.2	90.00	3.41	154.2	307.2	129.6	221.9	912.9	10.9	1.5	984.1
113	3	17.5	6.0	151.2	93.00	3.35	151.2	292.8	118.9	232.8	795.8	16.9	4.1	933.4
119	1	19.2	6.0	92.3	87.20	2.03	92.3	314.4	132.0	315.2	854.0	37.3	14.2	946.8
119	2	17.7	6.7	64.8	92.20	1.62	64.8	250.4	114.7	274.4	704.4	41.4	13.7	941.5
119	3	18.0	6.8	44.5	94.80	1.10	44.5	251.8	139.8	321.6	757.7	46.5	23.9	1096.1
IRRIGATED IN 0.25-M ROWS (I25)														
28	1	1.9	0.0	6.6	9.00	0.14	6.6	2.7	-	-	9.3	-	-	-
28	2	1.7	0.0	7.5	8.80	0.16	7.5	2.7	-	-	10.2	-	-	-
28	3	1.8	0.0	7.7	8.40	0.16	7.7	2.7	-	-	10.4	-	-	-
35	1	2.9	0.0	11.2	10.50	0.24	11.2	5.3	-	-	16.5	-	-	-
35	2	3.1	0.0	15.2	11.30	0.30	15.2	5.8	-	-	21.0	-	-	-
35	3	4.1	0.0	23.4	13.70	0.49	23.4	10.6	-	-	33.9	-	-	-
42	1	4.6	0.0	18.2	14.40	0.40	18.2	9.1	-	-	27.4	-	-	-
42	2	5.8	0.0	29.1	17.60	0.63	29.1	14.1	-	-	43.2	-	-	-
42	3	5.8	0.0	34.1	18.00	0.74	34.1	16.8	-	-	50.9	-	-	-
49	1	7.3	0.0	55.7	22.10	1.44	55.7	34.6	-	-	90.2	-	-	-
49	2	7.9	0.0	57.4	23.30	1.49	57.4	34.6	-	-	110.4	-	-	-
49	3	8.1	0.0	73.8	26.40	1.92	73.8	47.7	-	-	121.4	-	-	-
56	1	9.1	0.0	85.6	29.60	3.84	85.6	66.4	-	-	152.0	-	-	-
56	2	9.4	0.0	79.5	33.40	2.56	79.5	72.2	-	-	151.7	-	-	-
56	3	9.4	0.4	92.5	36.70	3.68	92.5	93.8	-	-	186.2	-	-	-
64	1	11.8	2.0	148.8	47.60	4.94	148.8	160.0	-	-	308.8	10.2	1.8	-
64	2	12.3	2.0	159.0	53.20	5.42	159.0	186.4	-	-	345.4	12.0	2.2	-
64	3	12.2	2.0	133.9	52.70	4.33	133.9	151.0	-	-	284.8	11.1	2.0	-
71	1	14.2	2.0	216.8	71.00	7.44	216.8	283.8	0.3	-	500.9	2.8	0.5	109.3
71	2	15.2	2.0	194.4	68.00	7.08	194.4	266.4	0.3	-	461.1	1.6	0.3	42.7
71	3	14.7	2.0	159.0	69.00	5.20	159.0	205.9	0.3	-	365.1	0.5	0.1	16.0
79	1	15.7	3.0	202.4	85.00	7.03	202.4	308.8	2.9	-	514.2	28.4	4.8	109.3
79	2	17.8	3.0	209.1	90.00	7.10	209.1	339.8	4.3	-	553.1	31.0	5.2	18.7
79	3	16.5	3.0	173.9	87.00	7.01	173.9	312.0	1.6	-	487.5	29.3	6.3	80.0
86	1	20.0	3.7	204.3	100.00	6.50	204.3	404.1	49.1	-	657.4	13.3	10.9	874.8
86	2	19.3	3.7	193.4	103.00	5.42	193.4	350.7	36.0	-	580.1	10.6	6.9	632.1
86	3	19.3	3.7	222.7	103.00	6.27	222.7	420.9	41.3	-	684.9	18.9	8.4	712.1
91	1	21.7	4.7	204.3	104.30	5.39	204.3	421.1	89.1	-	714.5	14.9	5.9	1061.5
91	2	21.3	4.3	223.6	113.60	5.86	223.6	429.1	64.3	-	715.3	8.2	4.3	866.1
91	3	20.8	4.5	226.2	103.50	6.33	226.2	407.0	64.3	-	697.4	9.0	2.3	900.8
99	1	21.2	5.0	217.1	110.80	5.28	217.1	439.0	139.2	72.0	867.3	8.7	6.2	1370.8
99	2	18.0	4.8	140.6	108.80	4.28	140.6	318.2	78.9	35.5	573.9	9.7	3.3	805.4
99	3	20.7	4.8	174.2	112.00	5.17	174.2	373.6	100.3	29.1	677.2	11.0	6.8	962.8

TABLE 8.—DRY MATTER PRODUCTION AND PLANT DEVELOPMENT DATA FOR SOYBEANS GROWN DURING 1979. STAGE OF DEVELOPMENT ESTIMATES BY FEHR AND CAVINESS METHOD (1977). TOTAL DM DOES NOT INCLUDE SHED MATERIAL—CONTINUED

DAYS AFTER PLANTING	REP	STAGE OF DEVELOPMENT		PLANT HEIGHT (CM)	LA1	PLANT MASS (G/M2)					POD NUMBER PER M2	
		VEG	REPRO			LEAF	STEM PLUS PETIOLE	POD WALL	SEAN	TOTAL		SHED LEAF
IRRIGATED IN 0.25-M ROWS (125)---CONTINUED												
105	1	20.3	5.5	107.30	4.68	155.8	372.0	97.1	82.1	707.0	9.8	4.3
105	2	22.0	5.2	113.60	5.84	232.3	520.9	171.2	117.1	1041.5	10.9	5.8
105	3	21.3	5.3	101.20	4.78	204.8	429.7	149.1	112.0	895.6	12.5	5.7
113	1	22.0	6.0	114.00	3.53	185.1	423.5	128.3	209.6	946.5	7.2	6.1
113	2	22.3	6.0	122.00	4.12	177.9	437.9	137.6	216.8	970.3	16.2	6.2
113	3	23.0	6.0	121.00	5.51	255.5	555.5	180.0	239.0	1230.0	5.4	7.0
119	1	22.3	6.0	116.30	3.43	170.4	457.7	61.1	251.2	940.4	15.2	0.8
119	2	22.0	6.0	126.00	2.84	114.9	379.5	72.8	305.4	872.6	16.4	7.4
119	3	22.8	6.0	114.50	3.79	177.9	440.9	164.8	338.7	1122.3	17.0	3.1
128	1	22.2	6.5	110.60	1.59	68.0	329.1	120.0	286.7	803.8	49.2	19.6
128	2	22.2	6.5	114.20	1.28	65.3	342.2	145.9	313.4	866.8	61.5	15.9
128	3	22.2	6.5	112.80	1.71	89.1	400.3	155.0	329.9	974.3	52.8	21.1
IRRIGATED IN 1.0-M ROWS (1100)												
28	1	1.7	0.0	9.00	0.14	6.4	2.7	-	-	9.1	-	-
28	2	1.7	0.0	8.50	0.16	7.7	2.7	-	-	10.4	-	-
28	3	2.0	0.0	9.20	0.16	7.4	3.0	-	-	10.4	-	-
35	1	2.7	0.0	11.20	0.20	10.2	5.0	-	-	15.2	-	-
35	2	3.6	0.0	14.10	0.34	15.5	7.5	-	-	23.0	-	-
35	3	3.9	0.0	14.90	0.36	15.8	9.4	-	-	29.3	-	-
42	1	5.0	0.0	16.80	0.44	19.5	10.1	-	-	29.6	-	-
42	2	5.5	0.0	18.80	0.69	29.1	14.4	-	-	43.5	-	-
42	3	5.9	0.0	20.80	0.85	35.5	19.0	-	-	54.6	-	-
49	1	7.6	0.0	26.70	1.39	42.9	35.2	-	-	78.1	-	-
49	2	7.8	0.0	28.10	1.40	53.4	35.5	-	-	89.0	-	-
49	3	7.7	0.0	30.80	1.70	64.0	42.2	-	-	106.2	-	-
56	1	9.2	0.0	36.70	2.32	79.0	65.6	-	-	144.6	-	-
56	2	9.2	0.3	40.70	3.16	105.3	91.0	-	-	196.3	-	-
56	3	9.6	0.4	43.50	2.73	82.2	73.9	-	-	156.2	-	-
64	1	11.7	2.0	49.80	3.87	133.9	135.2	-	-	269.1	3.6	0.7
64	2	11.0	1.8	55.70	3.47	118.9	131.2	-	-	250.2	8.0	1.4
64	3	11.3	2.0	59.20	3.29	119.5	129.3	-	-	248.8	6.3	1.1
71	1	15.2	2.0	68.00	6.74	217.6	245.1	1.1	-	463.8	1.7	0.3
71	2	15.2	2.0	72.00	7.30	232.6	258.2	1.1	-	463.8	1.7	0.3
71	3	15.2	2.0	72.00	7.30	232.6	258.2	1.1	-	463.8	1.7	0.3
79	1	16.2	3.0	80.00	6.40	187.2	252.3	5.6	-	445.1	12.6	1.5
79	2	16.2	3.2	87.00	6.08	163.2	243.5	5.3	-	412.1	14.7	3.2
79	3	16.5	3.2	86.00	5.36	250.2	325.9	10.1	-	586.2	12.6	2.0
86	1	19.3	3.7	93.00	8.16	267.2	443.0	57.9	-	768.1	6.9	3.8
86	2	17.5	4.3	96.00	4.92	176.0	314.2	40.5	-	530.7	11.9	5.3
86	3	19.3	4.0	100.00	5.37	201.1	323.0	50.7	-	574.7	14.7	4.8
91	1	20.0	4.3	93.80	7.04	253.1	461.7	90.4	-	805.2	6.2	1.3
91	2	20.3	4.8	101.10	5.16	227.2	391.8	110.9	-	730.0	14.5	3.5
91	3	21.2	5.0	99.00	7.97	317.6	563.5	119.7	-	1000.9	15.5	1.5
99	1	21.0	4.8	99.80	6.06	269.9	535.8	143.8	46.7	996.1	12.1	1.2
99	2	21.2	5.0	106.30	4.87	195.5	449.9	144.0	69.6	859.0	1.6	1.6
99	3	22.3	5.2	111.50	5.64	234.2	519.3	156.6	85.3	995.3	3.5	0.9
105	1	22.7	5.0	102.00	5.57	213.1	430.2	149.6	81.3	874.2	14.4	2.9
105	2	22.7	5.5	111.30	5.18	221.4	457.7	161.9	167.8	1008.2	1.7	2.0
105	3	22.6	5.3	110.30	5.36	273.4	513.9	187.5	163.5	1138.3	11.1	4.1
113	1	21.8	6.0	106.00	5.13	252.0	536.1	192.6	295.8	1276.4	8.3	5.4
113	2	22.3	6.0	109.00	5.07	256.3	459.8	177.1	324.0	1217.2	11.3	8.7
113	3	23.3	6.0	111.00	5.30	258.7	529.9	191.2	274.7	1254.6	13.3	14.4
119	1	21.3	6.0	112.30	2.93	149.6	429.9	146.4	251.2	977.2	23.0	1.7
119	2	20.2	6.5	101.50	2.05	86.9	325.4	142.7	351.2	906.2	32.1	5.7
119	3	21.2	6.0	114.50	2.86	143.0	395.0	154.2	340.0	1032.1	23.0	4.9
128	1	20.8	7.0	99.30	0.47	28.0	331.0	148.8	270.4	778.2	57.3	19.6
128	2	20.8	7.0	101.80	0.35	2.9	265.9	138.2	355.4	751.3	27.6	10.5
128	3	21.0	7.0	105.70	0.12	6.7	307.0	155.2	338.4	807.3	6.7	18.5

**TABLE 9.—DISTRIBUTION OF LEAF AREA AND COMPONENT MASSES (JULY 31) 77 DAYS AFTER PLANTING. VALUES ARE MEANS OF THREE REPLICATES FOR 1.0 M ALONG THE ROWS**

	Height (m)	Distance From a Mid-row Point (m)				Distance From a Mid-row Point (m)				Row Totals
		0-.2	.2-.4	.4-.6	.6-.8	0-.2	.2-.4	.4-.6	.6-.8	
[nonirrigated soybeans]										
Leaf Area (cm <sup>2</sup> )	> .8	0	0	0	0	0	264	819	24	0
	.6-.8	1962	941	1084	1264	1097	4073	4735	4114	134
	.4-.6	3638	3979	3471	3924	4370	19382	4836	4539	926
	.2-.4	3246	4033	3170	3857	17854	1213	4444	4674	1660
	0-.2	339	267	443	334	401	1784	831	1666	993
Column Totals		9184	9219	8168	9380	9416	14339	14647	15018	3715
Leaf Mass (g)	> .8	0.0	0.0	0.0	0.0	0.0	0.8	2.3	0.0	0.0
	.6-.8	9.9	5.0	5.5	6.5	4.3	13.1	15.5	8.7	0.7
	.4-.6	15.8	17.9	15.2	17.4	19.4	85.8	13.6	15.4	4.3
	.2-.4	10.9	13.9	10.6	13.8	12.9	62.2	10.3	18.1	11.2
	0-.2	1.0	0.7	1.3	1.0	1.5	5.5	2.4	12.7	9.0
Column Totals		37.6	37.6	32.7	38.7	38.1	51.8	44.1	54.9	25.1
Stem Plus Petiole Mass (g)	> .8	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	1.5
	.6-.8	2.5	6.2	7.1	6.3	0.5	2.7	10.1	1.9	0.0
	.4-.6	8.1	11.1	7.1	8.5	7.1	42.0	5.4	29.0	6.2
	.2-.4	14.5	15.6	6.4	16.8	7.2	60.5	8.3	66.6	9.1
	0-.2	19.6	17.1	3.0	16.1	17.7	73.6	0.8	83.6	3.8
Column Totals		44.8	50.0	23.5	47.8	32.6	17.2	190.9	21.1	232.5
Total Mass (g)	> .8	0.0	0.0	0.0	0.0	0.0	0.8	3.8	0.0	0.0
	.6-.8	12.4	10.8	12.5	12.7	4.9	53.3	25.6	10.6	0.7
	.4-.6	23.9	29.1	22.3	25.9	26.5	127.7	42.6	21.6	4.5
	.2-.4	25.4	29.5	17.0	30.6	20.1	122.7	7.9	27.2	12.5
	0-.2	20.6	17.7	4.3	17.1	19.2	79.0	8.3	86.0	9.5
Column Totals		82.4	87.6	56.2	86.4	70.7	24.9	235.0	76.0	27.1
[irrigated soybeans]										
Leaf Area (cm <sup>2</sup> )	> .8	3249	2048	1863	1453	4404	13019	2139	4191	95
	.6-.8	7759	3430	4006	3511	5324	24032	3833	2101	1985
	.4-.6	5708	4195	4024	4323	6061	24313	2636	3259	1898
	.2-.4	1476	1115	1889	1863	1217	7062	2473	1842	2730
	0-.2	963	262	215	20	658	2121	1476	418	782
Column Totals		19157	11052	11499	11172	17666	70549	10111	11583	6023
Leaf Mass (g)	> .8	1.7	0.9	1.1	0.7	2.5	6.9	3.1	6.1	0.5
	.6-.8	10.7	6.9	10.4	6.4	11.6	46.1	11.5	15.5	9.3
	.4-.6	21.1	12.1	13.0	16.3	23.5	86.1	9.0	27.5	6.5
	.2-.4	21.5	21.4	17.1	15.5	27.3	102.9	8.3	47.8	13.4
	0-.2	25.2	24.5	4.8	23.9	33.0	111.5	7.9	10.8	2.8
Column Totals		80.2	65.8	46.4	63.0	98.0	353.4	55.4	164.7	26.9
Stem Plus Petiole Mass (g)	> .8	15.6	10.9	10.5	7.8	21.8	66.6	3.1	10.9	6.8
	.6-.8	37.1	19.8	25.2	19.3	32.0	133.5	20.1	26.8	17.3
	.4-.6	37.2	24.7	24.9	29.7	42.2	158.7	33.2	37.8	18.4
	.2-.4	25.0	24.4	21.5	20.4	30.5	121.9	23.7	52.7	21.7
	0-.2	27.9	25.4	5.5	24.0	35.2	117.9	21.3	78.6	5.4
Column Totals		142.8	105.3	87.7	101.3	161.6	598.6	101.5	206.8	69.6

TABLE 10.—DISTRIBUTION OF LEAF AREA, POD NUMBER, AND COMPONENT MASSES (AUGUST 22) 99 DAYS AFTER PLANTING. VALUES ARE MEANS OF THREE REPLICATES FOR 1.0 M ALONG THE ROWS

	Height (m)	Distance From a Mid-row Point (m)					Row Totals	Distance From a Mid-row Point (m)					Row Totals
		0-.2	.2-.4	.4-.6	.6-.8	.8-1.0		0-.2	.2-.4	.4-.6	.6-.8	.8-1.0	
[Irrigated soybeans]													
1.0-m rows (1100)													
Leaf Area (cm <sup>2</sup> )	> .8	5573	4897	5185	3889	1382	20927	4108	4989	2631	0	12895	
	.6-.8	4389	4514	3936	3575	2510	18926	5723	5354	3945	460	20056	
	.4-.6	2007	974	1358	1490	2017	7846	2008	2783	3918	2567	14359	
	.2-.4	109	467	49	53	93	773	1447	993	901	652	4935	
	0-.2	99	176	382	0	0	657	1436	749	196	520	2988	
Column Totals		12178	11030	10911	9007	6003	49131	14656	14151	11592	4201	55233	
1.0-m rows (1100)													
Pod Number	> .8	38.7	24.7	36.0	16.7	7.3	123.4	4.7	46.7	4.7	0.0	80.0	
	.6-.8	48.7	38.0	39.4	26.0	11.3	163.4	20.7	67.4	14.7	0.0	138.7	
	.4-.6	60.0	73.4	70.0	80.0	25.3	308.8	48.7	83.4	26.7	4.0	288.1	
	.2-.4	70.7	74.7	46.0	54.7	63.4	309.5	27.3	98.0	36.0	17.3	441.6	
	0-.2	26.7	30.0	6.0	29.3	18.0	110.1	9.3	24.0	10.0	9.3	150.1	
Column Totals		244.8	240.8	197.4	206.8	125.4	1015.2	265.5	599.6	92.0	30.7	1098.5	
1.0-m rows (1100)													
Leaf Mass (g)	> .8	27.6	24.7	25.6	20.9	7.9	106.7	6.7	20.8	15.1	0.0	66.6	
	.6-.8	16.0	15.7	13.9	13.7	9.1	68.6	15.0	23.7	19.7	2.1	85.2	
	.4-.6	4.9	2.7	3.9	4.1	5.5	21.1	7.1	10.9	9.2	4.2	45.5	
	.2-.4	0.3	0.9	0.1	0.1	0.1	1.6	3.3	2.5	2.3	2.4	12.7	
	0-.2	0.2	0.4	0.9	0.0	0.0	1.5	4.5	3.4	0.5	1.9	10.7	
Column Totals		49.0	44.6	44.5	38.8	22.6	199.5	36.8	61.2	51.8	10.3	220.8	
1.0-m rows (1100)													
Stem Plus Petiole Mass (g)	> .8	9.3	8.9	7.9	5.5	2.1	33.8	1.1	4.3	1.7	0.0	23.5	
	.6-.8	17.1	16.6	16.0	13.0	5.1	67.8	5.7	15.2	5.9	0.0	48.6	
	.4-.6	22.7	22.3	17.3	26.3	9.7	98.3	13.7	26.1	42.4	2.6	93.6	
	.2-.4	21.3	20.7	15.1	14.5	17.3	88.9	6.3	23.9	67.6	4.3	114.1	
	0-.2	26.3	30.9	3.8	28.7	23.3	113.2	3.1	9.3	100.2	3.5	118.9	
Column Totals		96.8	99.4	60.2	88.0	57.6	402.1	29.9	78.8	248.4	10.3	398.7	
1.0-m rows (1100)													
Pod Mass (g)	> .8	3.2	2.1	2.1	1.1	0.9	9.5	0.5	1.9	0.3	0.0	6.9	
	.6-.8	5.7	4.9	6.1	3.0	1.8	21.5	1.3	4.7	1.9	0.0	19.2	
	.4-.6	10.5	11.6	11.4	10.6	4.2	48.3	5.9	17.0	24.9	0.6	52.3	
	.2-.4	12.7	11.5	8.5	8.1	9.9	50.8	4.3	15.5	52.0	2.5	80.3	
	0-.2	2.9	3.4	0.6	4.4	2.3	13.6	1.0	3.6	1.9	0.8	21.2	
Column Totals		34.9	33.6	28.8	27.3	19.1	143.7	13.1	42.7	106.3	3.9	180.0	
1.0-m rows (1100)													
Total Mass (g)	> .8	40.2	35.8	35.7	27.5	10.8	150.0	8.3	27.1	44.5	0.0	97.0	
	.6-.8	38.8	37.2	36.1	29.7	16.1	157.9	22.0	43.6	57.8	2.1	153.0	
	.4-.6	38.2	36.6	32.7	41.0	19.3	167.8	26.8	54.0	76.5	7.4	191.4	
	.2-.4	34.3	33.1	23.7	22.7	27.4	141.3	14.0	41.8	122.0	8.9	207.1	
	0-.2	29.4	34.8	5.3	33.1	25.7	128.3	8.6	16.3	114.5	6.1	150.8	
Column Totals		180.8	177.6	133.5	154.1	99.3	745.2	79.7	182.8	415.3	24.5	799.4	





TABLE 11.—YIELD AND YIELD COMPONENTS FOR IRRIGATED AND NONIRRIGATED SOYBEANS PLANTED IN 0.25-M AND 1.0-M ROWS. SEED YIELD AND 100 SEED MASS FROM 24.71 M<sup>2</sup> AREAS; POD NUMBER AND SEEDS/POD FROM 10 PLANT SAMPLES COLLECTED AT HARVEST

TREAT- MENT	REP	SEED YIELD (kg/ha)	100 SEED MASS (g)	PDD NUMBER			SEEDS PER PDD		
				BRAN- CHES	MAIN STEM	TOTAL	BRAN- CHES	MAIN STEM	TOTAL
N25	1	2469	17.4	224	273	497	2.03	2.32	2.20
	2	2513	15.8	252	256	508	2.10	2.18	2.14
	3	<u>2527</u>	<u>16.6</u>	<u>348</u>	<u>312</u>	<u>660</u>	<u>2.07</u>	<u>2.15</u>	<u>2.11</u>
	MEANS	2503	16.6	275	280	555	2.07	2.22	2.15
N100	1	2304	16.7	183	217	400	2.16	2.17	2.17
	2	2053	16.3	111	289	400	2.10	2.06	2.07
	3	<u>1954</u>	<u>16.8</u>	<u>142</u>	<u>302</u>	<u>444</u>	<u>1.81</u>	<u>2.13</u>	<u>2.04</u>
	MEANS	2104	16.6	145	269	415	2.02	2.12	2.09
I25	1	2555	14.9	242	384	626	1.90	2.20	2.12
	2	2328	14.8	204	433	637	2.10	2.11	2.11
	3	<u>2425</u>	<u>14.6</u>	<u>95</u>	<u>399</u>	<u>494</u>	<u>2.01</u>	<u>2.12</u>	<u>2.09</u>
	MEANS	2436	14.8	180	405	586	2.00	2.14	2.11
I100	1	2001	14.2	156	381	537	2.21	2.21	2.21
	2	2363	15.2	248	293	541	1.94	1.94	1.94
	3	<u>1971</u>	<u>14.2</u>	<u>160</u>	<u>386</u>	<u>546</u>	<u>1.85</u>	<u>2.26</u>	<u>2.15</u>
	MEANS	2112	14.5	188	353	541	2.00	2.13	2.10

At this time, the soybeans were between reproductive stages R6 (full green beans at one of the upper four nodes) and R7 (beginning maturity). Therefore, an inability to set pods or begin pod fillings did not prevent the irrigated plots and the 1.0-m rows from producing the highest yields. Rather, pod abortion caused by inadequate late season photosynthate supply seemed to be the major determinant of yield.

During the 30-days from August 13 to September 13, at least a trace of rainfall occurred on 14 days. These cloudy conditions, when combined with rapidly decreasing daylength and the rapid loss of leaves after September 1, could have reduced photosynthesis to the point at which yield was limited. This lack of carbohydrate supply could explain the small, poorly filled seeds of the irrigated plots (fig. 2).

Another possible explanation for the poorly filled seeds in the irrigated treatments lies in the September temperatures. A period of low temperatures occurred from September 12 to 22 (days 120 to 130). During this time, average maximum temperature was 20 percent below the rest of the month, minimum temperature was 41 percent below, and pan evaporation was 31 percent below the rest of September. This low-temperature period began when the nonirrigated plots had reached beginning maturity (stage R7), but the irrigated plots were still in the main podfill period (6). A 30°C optimum temperature for soybean photosynthesis has been suggested (12), compared with a 22.2°C average maximum during the September 12 to 22 period. Data from other reports (10, 17) suggest

TABLE 12.—AOV RESULTS FOR SEASONAL AND END-OF-SEASON PLANT PARAMETERS

Variable	Row spacing	Irrigation	I * R	Time * I	Time * R
Plant height	*	**	**	*	*
	1.0 > 0.25	I > N			
Vegetative stage	ns	*	ns	*	ns
		I > N			
Reproductive stage	*	**	ns	ns	ns
	1.0 > 0.25	N > I			
Leaf area	ns	*	ns	*	ns
		I > N			
Leaf mass	*	ns	ns	*	ns
	1.0 > 0.25				
Stem mass	(8.24)	*	ns	*	ns
	1.0 > 0.25	I > N			
Total pod mass	**	ns	ns	*	ns
	1.0 > 0.25				
Podwall mass	**	ns	ns	*	ns
	1.0 > 0.25				
Bean mass	*	ns	ns	ns	ns
	1.0 > 0.25				
Total mass	**	(7.14)	ns	*	ns
	1.0 > 0.25	I > N			
Pod number	**	ns	ns	*	ns
	1.0 > 0.25				
End of Season Analysis					
Seed yield	*	ns	ns	-	-
	0.25 > 1.0				
Pod number	*	ns	ns	-	-
	0.25 > 1.0				
Seeds per pod	ns	ns	ns	-	-
100 seed mass	ns	(5.01)	ns	-	-
		N > I			

<sup>1</sup>Significance levels of 5 percent (\*) and 1 percent (\*\*) are shown with actual P values presented if 10 percent > P > 5 percent. Sampling times were always highly significant (1 percent) and are not presented.

that development would have continued relatively unaffected by the cool temperatures, whereas photosynthetic production and the ensuing yield would have been reduced.

We established that the 0.25-m rows intercepted more radiation than the 1.0-m rows during canopy development (fig. 3). The pattern in figure 3 was probably repeated during the leaf-fall stage when pod-fill was occurring. We concluded that this inability of the soybeans in the 1.0-m rows to intercept as much radiation and produce as much photosynthate late in the season as the 0.25-m rows caused the yield difference. This conclusion is supported by the fact that, at the time of harvest, the plants in the 0.25-m row spacings had retained an average of 86 percent of their maximum pod number, whereas the plants in the 1.0-m rows had retained only 60 percent. Thus, while pod set was greatest in the 1.0-m rows, final pod number was greatest in the 0.25-m rows.

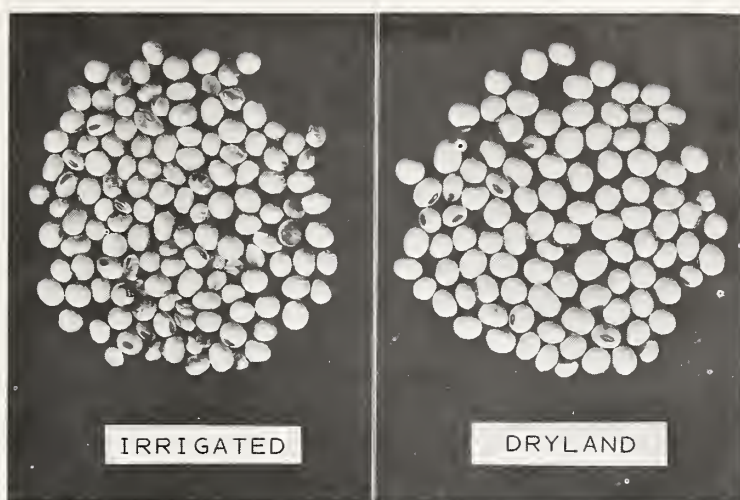


FIGURE 2.—Seeds from irrigated (I25) and nonirrigated soybeans. Samples represent all the seeds from a single plant in each case. There was no significant effect of row spacing on seed size. Seeds from the 1.0-m rows were similar in appearance to the seeds shown.

We found that the tissue concentrations and crop accumulation of nutrients were greater in the irrigated than in the nonirrigated treatments (see Data Set IV), and thus nutrient supply is unlikely to explain the fail-

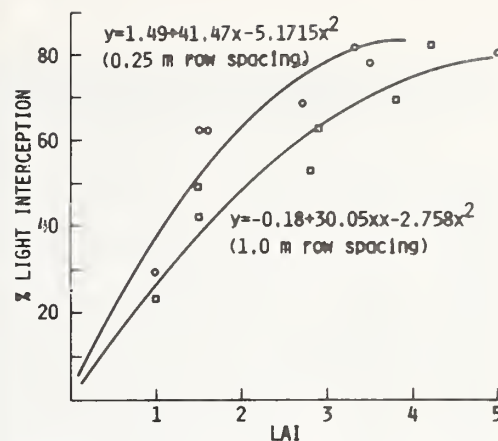


FIGURE 3.—Canopy light interception as a function of LAI for soybeans planted in 0.25-m rows (□) and 1.0-m rows (○) during canopy development. Values from both irrigated and nonirrigated plots were used.

ure of the irrigated plants to realize their greater yield potential for outyielding the nonirrigated plants. A more detailed discussion of the soybean growth and yield results presented here is available (36).

### DATA SET III. WATER RELATIONS AND ROOT GROWTH

#### Discussion

The plant growth data set showed that, in general, vegetative growth and pod and seed numbers were increased by irrigation, but final seed yield was not increased. Similarly, 1.0-m row plants produced a greater total season biomass and set more pods than the 0.25-m row plants, but the 0.25-m row plants produced an average of 370 kg/ha extra seed yield. We sampled the water content of the four treatments—nonirrigated 0.25-m rows (N25), nonirrigated 1.0-m rows (N100), irrigated 0.25-m rows (I25), and irrigated 1.0-m rows (I100)—16 times between June 12 and September 10 (fig. 1). The in-row and between-row soil water contents and available soil water (ASW) levels (water held above 0.1 cm<sup>3</sup>/cm<sup>3</sup> or approximately -1.5 MPa) are presented in table 13.

On June 12 (28 days after planting), the plots contained an average of 255 mm of ASW in the top 1.83 m of soil (table 13); however, this initial soil water content was not uniform over the entire area. Even though no irrigations had been applied at this time, the irrigated plots had an average of 27 mm more

ASW in the top 1.83 m than the nonirrigated plots. Also, soil water content in the irrigated plots increased from Replicate 1 to Replicate 3, or down the slope. Irrigation maintained this trend because runoff flowed from Replicate 1 to Replicate 3. The nonirrigated plots had a very even soil water distribution across replicates, and this distribution was maintained throughout the season.

The ASW level in the nonirrigated plots was gradually depleted until August 20 (day 97) when only 35 mm of ASW remained in the root zone (top 1.83 m). This amount was 15 percent of the ASW level on June 12. Some midday wilting appeared on plants in the nonirrigated plots at this stage. From day 98 until maturity, rainfall exceeded Class A pan evaporation, providing good soil water conditions during pod fill for all treatments. The lowest ASW level in the irrigated plots was also measured on day 97 when approximately 200 mm remained in the top 1.83 m of soil. Because a high soil water level was maintained throughout the growth season, we believe the growth and yield of the irrigated soybeans can be considered free of soil water stress.

Text continues on page 28.



TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE. DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M

JUNE 12 1979. DAYS AFTER PLANTING = 28

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	25.27	25.05	23.89	22.72	23.13	21.93	22.00	22.75	23.46	21.71
	2	24.00	23.40	23.14	22.76	22.70	23.47	22.53	21.30	22.40	23.12
BETWEEN ROWS	1	23.81	24.96	22.82	22.87	22.98	23.89	22.49	22.32	23.01	22.19
	2	24.57	24.35	25.25	23.70	22.35	22.60	22.40	22.19	23.07	23.26
	3	26.63	25.15	22.04	25.06	23.29	22.42	23.22	24.42	23.87	22.52
MEAN WATER CONTENT		25.10	24.53	23.31	23.75	22.93	22.74	22.53	22.64	23.08	22.44
CUMULATIVE ASW		22.6	44.4	84.4	125.6	164.4	202.6	240.2	278.2	317.4	354.7
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	22.42	25.76	23.42	23.31	23.01	22.78	22.96	22.79	22.78	22.72
	2	24.49	23.27	21.52	24.88	23.20	23.03	23.25	23.76	23.22	23.15
BETWEEN ROWS	1	23.15	23.39	24.20	25.31	23.76	23.90	23.20	23.51	22.58	22.51
	2	25.84	25.07	22.10	23.91	22.64	22.65	23.08	23.27	23.97	23.61
	3	26.94	23.88	22.29	23.04	24.72	23.42	22.72	22.83	23.68	22.91
MEAN WATER CONTENT		24.50	23.94	22.73	23.94	23.69	23.32	22.97	23.13	23.05	22.87
CUMULATIVE ASW		21.7	42.7	80.9	122.7	163.8	203.7	242.6	282.0	321.2	359.8
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	23.91	25.35	22.62	21.81	22.67	22.48	21.07	21.55	21.24	21.20
	2	32.24	28.05	27.84	26.26	25.04	24.40	26.23	23.62	22.04	22.29
BETWEEN ROWS	1	25.26	25.52	22.84	22.03	22.67	22.76	20.94	20.48	20.66	26.26
	2	26.69	29.57	28.57	25.19	24.72	23.60	25.65	23.51	21.82	22.19
	3	30.25	29.63	27.29	24.97	23.57	23.26	24.50	24.24	22.98	23.42
MEAN WATER CONTENT		27.30	27.69	26.06	24.22	23.72	23.36	23.82	22.77	22.00	22.96
CUMULATIVE ASW		26.7	53.2	101.4	144.1	185.2	225.3	266.8	305.1	341.1	380.0
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	27.39	26.50	26.40	23.70	21.79	21.23	23.06	20.91	20.42	20.46
	2	27.79	26.87	27.45	24.84	25.29	25.50	24.61	24.39	23.08	23.07
BETWEEN ROWS	1	25.94	27.35	24.57	22.83	21.54	20.45	22.56	21.42	20.25	20.37
	2	28.38	29.55	27.49	24.43	25.44	25.30	25.08	23.74	23.25	22.92
	3	27.55	36.45	26.68	23.58	23.15	25.32	24.21	24.65	25.04	24.76
MEAN WATER CONTENT		27.44	28.53	26.39	23.98	23.39	24.04	24.17	23.17	22.79	22.93
CUMULATIVE ASW		26.2	54.0	103.1	145.1	185.2	227.3	269.8	309.4	347.7	386.5

JUNE 19 1979. DAYS AFTER PLANTING = 35

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	19.82	21.45	21.14	21.65	22.39	22.86	23.02	21.68	21.61	21.83
	2	21.55	22.09	21.83	23.17	23.34	22.41	21.27	22.53	27.49	21.65
BETWEEN ROWS	1	23.04	24.03	23.37	22.13	22.10	21.86	24.39	22.01	22.34	22.33
	2	22.17	23.48	22.94	23.78	23.52	22.76	26.15	23.08	22.06	21.93
	3	21.48	22.24	28.30	22.55	22.12	23.08	23.14	21.81	22.21	22.78
MEAN WATER CONTENT		21.12	22.27	23.09	22.59	22.59	22.36	23.20	22.04	23.33	22.34
CUMULATIVE ASW		16.7	35.1	74.3	112.1	149.9	187.0	226.5	262.7	302.6	339.7
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	21.64	22.45	22.24	20.83	23.65	23.29	22.65	22.38	22.82	22.66
	2	21.12	21.94	21.65	23.30	23.80	22.79	23.46	24.64	23.26	22.53
BETWEEN ROWS	1	21.15	21.98	22.64	22.40	23.78	22.97	22.21	22.25	22.74	22.73
	2	22.30	23.52	22.26	23.05	22.71	22.48	23.33	23.17	23.37	23.30
	3	22.92	22.79	21.73	25.05	23.16	23.45	22.81	22.03	23.33	22.52
MEAN WATER CONTENT		21.82	22.41	22.06	23.36	23.28	22.76	22.73	22.98	22.88	22.67
CUMULATIVE ASW		17.7	36.3	72.5	112.6	152.4	190.7	228.9	267.9	306.5	344.5
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	19.77	22.29	21.04	21.64	21.71	22.24	20.62	18.50	19.04	20.22
	2	20.60	23.40	21.33	20.70	22.34	21.02	20.58	22.33	20.63	22.14
BETWEEN ROWS	1	24.40	23.21	21.48	21.39	22.34	21.68	20.46	19.33	19.86	20.84
	2	23.09	24.56	21.35	22.05	22.99	22.70	20.46	21.62	21.26	22.17
	3	24.87	27.58	27.73	25.86	24.98	24.15	24.68	21.95	22.59	22.44
MEAN WATER CONTENT		22.39	24.49	22.99	22.89	23.10	22.45	21.78	20.95	20.91	21.82
CUMULATIVE ASW		18.6	40.3	79.3	118.0	157.2	194.6	229.9	262.8	295.5	331.0
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	21.40	23.35	19.52	21.54	22.62	22.26	21.89	22.22	22.65	22.29
	2	23.23	27.18	24.06	23.47	21.94	21.28	23.11	20.53	20.18	21.66
BETWEEN ROWS	1	21.65	23.57	20.51	22.13	23.03	22.42	22.40	22.61	23.56	22.35
	2	21.94	26.78	23.68	22.99	21.76	21.00	22.30	20.37	19.53	20.00
	3	25.52	27.99	27.03	24.52	24.96	25.47	25.70	25.47	23.63	23.32
MEAN WATER CONTENT		23.35	26.26	23.49	23.20	23.12	23.00	23.35	22.56	22.02	22.18
CUMULATIVE ASW		20.0	44.4	84.9	124.5	163.8	202.8	242.9	280.6	316.6	353.1

TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE. DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

JUNE 26 1979. DAYS AFTER PLANTING = 42

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	17.80	20.70	19.14	20.83	21.44	21.82	21.59	21.87	21.34	22.40
	2	18.14	20.25	20.42	21.76	21.74	21.12	21.43	20.89	21.31	22.25
	3	19.00	19.95	19.39	20.85	21.89	22.24	22.81	22.28	23.48	23.25
BETWEEN ROWS	1	18.79	23.37	21.48	21.78	20.28	21.94	21.72	21.05	20.17	20.47
	2	20.12	23.50	21.32	21.48	21.10	21.71	21.89	22.38	22.02	21.78
	3	19.69	22.12	21.01	22.22	21.97	22.59	22.31	21.93	22.26	23.30
MEAN WATER CONTENT		18.80	21.38	20.30	21.42	21.46	21.87	21.96	21.72	21.82	22.32
CUMULATIVE ASW		13.2	30.3	61.2	95.4	129.8	165.4	201.3	236.4	271.9	308.9
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	18.55	21.43	20.12	20.74	20.92	21.61	21.35	20.12	21.14	21.99
	2	19.05	21.63	21.31	22.21	22.23	21.52	21.90	22.72	21.74	21.71
	3	18.09	22.23	19.30	22.35	22.36	21.46	23.09	22.82	22.43	23.19
BETWEEN ROWS	1	17.87	21.63	20.99	21.76	22.08	21.87	22.42	22.08	22.37	22.65
	2	17.28	21.63	19.45	21.99	21.72	22.27	22.74	22.12	21.56	24.21
	3	21.32	23.87	20.53	22.14	22.58	23.00	22.80	23.07	23.57	22.83
MEAN WATER CONTENT		18.67	22.01	20.27	21.85	21.95	21.87	22.33	22.10	22.06	22.67
CUMULATIVE ASW		13.0	31.0	61.8	97.4	133.2	168.8	205.8	242.1	278.3	316.3
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	17.84	22.58	22.35	21.69	21.93	21.45	21.28	19.30	19.99	21.11
	2	19.56	22.52	20.31	21.17	22.45	23.29	20.94	21.28	21.79	22.27
	3	22.78	25.54	24.13	24.47	25.64	24.66	24.82	22.83	22.29	22.49
BETWEEN ROWS	1	19.82	23.17	22.39	21.44	21.35	22.36	21.23	19.68	19.70	21.52
	2	20.70	23.60	20.92	21.01	23.41	22.52	21.22	21.86	22.64	21.75
	3	23.55	27.95	27.13	24.79	24.50	23.65	24.86	23.25	22.31	22.79
MEAN WATER CONTENT		20.58	24.09	22.75	22.43	23.24	23.02	22.38	21.32	21.43	21.98
CUMULATIVE ASW		15.9	37.0	75.2	112.5	152.3	191.3	228.5	262.4	296.7	332.7
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	18.99	21.55	20.15	22.30	23.76	22.83	22.42	22.08	22.34	21.61
	2	21.64	26.28	23.60	21.82	22.84	21.78	24.11	20.83	21.23	21.63
	3	21.34	27.03	24.81	23.46	23.61	22.40	24.23	21.86	21.50	21.51
BETWEEN ROWS	1	18.31	21.39	20.15	21.14	23.51	21.43	21.07	21.50	21.94	21.70
	2	19.81	24.52	22.83	22.63	21.88	21.19	23.15	19.90	21.06	21.47
	3	22.95	27.59	26.17	25.14	24.94	25.15	27.32	23.46	23.91	23.83
MEAN WATER CONTENT		20.54	24.77	22.93	22.71	23.42	22.44	23.69	21.60	21.93	21.88
CUMULATIVE ASW		15.8	38.0	76.8	114.9	155.1	192.5	233.5	268.3	304.1	339.8

JULY 2 1979. DAYS AFTER PLANTING = 48

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	15.19	18.12	19.61	20.06	21.54	22.25	21.52	19.80	21.04	22.34
	2	15.45	17.65	19.74	21.54	22.10	21.37	22.46	22.13	21.60	20.60
	3	15.38	15.82	18.40	20.76	22.43	22.82	23.27	22.35	23.08	23.50
BETWEEN ROWS	1	17.87	20.58	21.60	20.96	21.70	23.95	21.41	20.46	22.04	22.27
	2	18.74	20.32	19.89	22.03	25.37	21.92	22.90	22.81	21.52	20.77
	3	17.53	18.21	20.11	21.95	20.65	22.24	23.56	23.04	22.69	23.42
MEAN WATER CONTENT		16.42	18.20	19.76	21.13	22.24	22.37	22.50	21.70	21.98	22.15
CUMULATIVE ASW		9.6	21.9	51.2	84.6	121.4	158.5	196.0	231.0	267.0	303.4
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	14.19	18.00	20.32	20.86	21.66	22.54	21.42	20.79	22.26	23.40
	2	14.76	19.20	19.11	21.34	22.51	22.95	22.52	22.91	23.13	22.84
	3	14.63	16.85	19.06	21.66	23.17	21.70	22.72	23.86	24.16	23.00
BETWEEN ROWS	1	16.09	17.97	20.84	21.86	22.31	22.72	22.05	21.48	22.05	22.61
	2	14.13	20.67	20.50	21.42	22.74	22.69	22.57	22.35	23.95	22.98
	3	15.01	18.01	20.59	23.81	22.13	22.55	23.17	22.70	23.05	22.43
MEAN WATER CONTENT		14.75	18.36	19.96	21.71	22.42	22.50	22.37	21.61	22.92	22.92
CUMULATIVE ASW		7.1	19.7	49.5	84.7	122.0	159.5	196.6	233.7	273.1	311.8
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	17.93	21.63	21.71	21.37	21.57	21.60	21.46	20.22	20.71	21.84
	2	22.52	24.26	21.78	21.68	21.73	22.97	20.49	21.83	22.82	22.25
	3	24.14	26.65	23.81	23.85	24.54	23.75	25.90	22.64	21.93	22.48
BETWEEN ROWS	1	20.11	21.80	20.34	20.58	21.84	22.29	20.45	19.89	20.74	21.04
	2	24.15	26.24	26.95	22.16	21.63	24.39	21.15	21.64	22.66	22.50
	3	25.56	29.86	28.07	24.80	24.42	24.36	25.91	23.50	22.95	23.29
MEAN WATER CONTENT		22.23	24.90	23.51	22.38	22.62	23.14	22.57	21.61	21.94	22.22
CUMULATIVE ASW		18.3	40.7	81.2	118.4	156.2	195.6	233.3	268.2	304.0	340.7
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	19.21	22.51	21.30	22.20	23.15	24.62	23.83	22.43	23.21	21.95
	2	23.43	24.53	24.22	22.78	22.86	21.71	24.56	22.49	20.04	21.72
	3	24.32	26.07	24.96	24.71	24.03	23.60	24.88	23.92	23.32	22.64
BETWEEN ROWS	1	20.46	22.71	21.16	21.06	22.34	22.16	21.68	21.80	22.89	21.20
	2	24.31	26.43	23.68	23.06	23.14	21.51	24.50	22.24	21.94	23.08
	3	24.06	26.85	25.61	21.04	24.52	24.43	25.88	23.39	22.97	29.86
MEAN WATER CONTENT		22.57	24.75	23.49	22.63	23.34	23.07	24.26	22.76	22.36	23.15
CUMULATIVE ASW		18.9	41.0	81.4	119.3	159.4	198.6	241.3	279.6	316.7	356.1

TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE, DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

JULY 5 1979. DAYS AFTER PLANTING = 51

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS		REP									
IN ROW	1	13.97	16.16	17.84	19.79	20.83	21.63	21.48	21.02	21.07	22.38
	2	15.44	16.00	18.06	20.39	21.35	21.50	22.14	21.80	21.63	20.61
	3	12.60	14.22	16.29	19.53	21.13	21.23	22.35	22.92	23.22	23.84
BETWEEN ROWS	1	16.78	18.47	19.49	20.57	20.59	20.97	22.11	21.10	20.90	21.83
	2	16.47	19.15	19.20	21.00	22.35	21.33	22.63	22.81	21.67	21.14
	3	17.25	19.06	20.43	21.44	21.72	24.69	22.23	21.11	22.05	23.88
MEAN WATER CONTENT			15.14	16.83	18.32	20.34	21.28	21.80	22.13	21.82	22.28
CUMULATIVE ASW			7.7	18.0	42.9	73.9	107.8	143.2	179.6	215.0	250.4
NONIRRIGATED 0.25M ROWS		REP									
IN ROW	1	13.53	15.49	17.74	18.97	21.22	22.25	21.28	21.05	22.20	23.46
	2	14.15	16.93	17.14	21.11	21.58	21.41	21.92	21.84	21.73	21.76
	3	15.44	18.41	16.81	20.00	21.23	21.22	22.43	24.03	23.42	23.00
BETWEEN ROWS	1	12.97	17.32	17.51	19.91	21.31	21.74	23.58	20.58	20.85	21.65
	2	12.10	16.61	19.35	21.56	20.34	20.42	20.39	21.18	20.84	20.88
	3	15.01	18.63	18.73	20.25	21.43	22.40	22.90	24.47	24.05	22.65
MEAN WATER CONTENT			13.97	17.17	17.75	20.25	21.22	21.59	22.04	22.24	22.34
CUMULATIVE ASW			6.0	16.7	40.0	70.7	104.3	139.1	175.2	211.9	248.6
IRRIGATED 1.0M ROWS		REP									
IN ROW	1	28.37	27.82	24.42	22.72	21.57	22.47	21.89	20.99	20.90	21.87
	2	31.32	29.96	23.45	20.79	22.50	23.03	21.63	22.32	21.84	23.40
	3	34.17	32.73	31.41	27.43	26.37	25.35	27.67	24.47	23.45	23.68
BETWEEN ROWS	1	28.47	26.11	23.14	21.20	21.81	22.60	21.40	20.59	21.27	21.98
	2	29.84	29.05	24.77	21.44	22.69	22.68	21.53	22.65	23.13	22.97
	3	32.67	33.53	32.73	27.07	25.40	25.03	28.01	23.68	22.75	22.51
MEAN WATER CONTENT			30.90	29.93	26.61	23.48	23.41	23.54	23.70	22.48	22.78
CUMULATIVE ASW			31.4	61.2	111.1	151.5	191.7	232.4	273.5	310.9	347.5
IRRIGATED 0.25M ROWS		REP									
IN ROW	1	29.68	28.90	24.22	21.84	24.50	23.11	23.37	23.51	23.76	22.67
	2	32.45	31.79	26.42	24.82	24.92	22.68	23.88	22.23	23.49	24.02
	3	36.29	32.72	30.60	25.69	25.16	24.99	26.69	24.59	23.88	24.42
BETWEEN ROWS	1	29.49	29.41	25.31	23.27	24.34	23.31	23.09	23.26	23.34	22.21
	2	32.87	30.43	26.64	22.90	24.15	22.43	24.06	21.59	22.17	23.05
	3	36.00	33.94	32.01	26.83	25.33	25.57	27.24	23.90	23.24	23.97
MEAN WATER CONTENT			32.80	31.19	27.44	24.20	24.76	24.71	23.23	23.39	23.45
CUMULATIVE ASW			34.2	66.0	118.3	160.9	205.2	246.2	290.3	330.0	410.5

JULY 12 1979. DAYS AFTER PLANTING = 58

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS		REP									
IN ROW	1	12.14	14.02	14.66	16.57	20.37	20.77	21.51	20.50	21.36	22.68
	2	14.75	14.85	14.47	18.86	20.57	20.60	21.65	21.73	20.33	20.36
	3	12.45	14.04	15.65	18.13	21.03	21.24	21.85	22.13	22.70	23.87
BETWEEN ROWS	1	13.23	17.21	17.63	18.51	20.54	20.98	21.36	19.54	21.18	21.88
	2	14.67	16.97	17.06	20.96	22.08	20.89	21.67	21.76	21.12	21.03
	3	13.84	14.96	18.94	19.52	21.07	21.04	21.77	22.47	23.02	24.08
MEAN WATER CONTENT			13.43	15.13	16.11	18.58	20.89	20.91	21.64	21.37	21.59
CUMULATIVE ASW			5.2	12.9	31.2	56.9	89.6	122.3	157.2	191.3	226.1
NONIRRIGATED 0.25M ROWS		REP									
IN ROW	1	12.46	14.04	14.67	17.70	20.34	21.01	19.77	19.13	20.44	21.19
	2	12.28	14.58	14.71	19.33	21.40	20.66	22.04	21.14	20.81	20.80
	3	11.14	14.09	14.37	19.54	20.65	21.72	21.82	21.33	21.59	22.22
BETWEEN ROWS	1	12.90	13.64	14.35	17.27	20.73	22.47	21.03	20.68	22.15	21.30
	2	11.36	13.04	15.17	20.11	21.53	21.34	21.55	21.81	20.85	21.92
	3	12.02	14.70	14.57	20.01	20.53	21.63	22.16	23.07	21.65	22.51
MEAN WATER CONTENT			12.01	14.06	14.63	18.97	20.85	21.40	21.36	21.06	21.19
CUMULATIVE ASW			3.0	9.1	23.0	49.9	82.4	116.6	150.7	183.9	217.5
IRRIGATED 1.0M ROWS		REP									
IN ROW	1	17.55	20.13	20.01	20.92	21.92	21.68	21.23	19.15	20.37	21.06
	2	19.02	22.69	20.05	20.94	23.28	22.15	21.53	20.65	22.40	22.77
	3	22.75	27.13	25.44	24.59	24.96	23.85	24.81	22.71	22.11	22.10
BETWEEN ROWS	1	18.42	21.95	20.81	21.86	21.86	21.91	21.47	20.28	20.45	22.18
	2	19.78	23.58	20.58	20.49	23.14	22.27	20.43	20.66	21.93	22.50
	3	21.38	25.20	25.00	24.10	23.93	23.47	24.53	22.48	22.80	22.85
MEAN WATER CONTENT			19.81	23.42	21.95	22.15	23.22	22.56	22.37	21.67	22.19
CUMULATIVE ASW			14.7	34.8	70.7	107.1	146.8	184.5	221.6	254.5	289.5
IRRIGATED 0.25M ROWS		REP									
IN ROW	1	17.27	20.10	19.01	21.24	21.05	21.85	21.25	20.65	20.73	22.38
	2	21.04	23.13	22.36	21.37	21.93	21.30	22.47	21.58	21.81	22.13
	3	19.09	22.68	21.93	22.82	23.37	23.10	24.13	22.10	21.38	21.75
BETWEEN ROWS	1	18.16	21.15	21.08	22.82	22.54	22.25	21.65	21.81	20.26	21.71
	2	21.62	25.22	21.19	20.57	20.64	22.51	23.63	21.52	22.25	21.19
	3	22.28	27.60	26.00	24.22	24.30	24.19	25.65	22.92	22.90	23.08
MEAN WATER CONTENT			19.76	23.05	21.76	22.10	22.27	22.44	23.03	21.70	21.51
CUMULATIVE ASW			14.6	34.2	69.5	105.8	142.6	179.9	219.0	254.1	288.6



TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE, DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

JULY 17 1979. DAYS AFTER PLANTING = 63

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	12.01	12.38	12.14	13.88	19.83	21.33	21.04	19.85	20.13	21.86
	2	14.15	14.04	12.59	14.85	20.46	21.11	20.28	20.91	21.54	20.62
BETWEEN ROWS	3	12.16	12.07	13.48	14.92	19.97	21.26	22.09	22.27	22.36	23.17
	1	12.31	13.95	14.63	17.84	20.65	20.49	20.25	20.47	21.29	22.56
	2	16.12	16.52	15.37	18.92	21.80	21.49	19.46	21.99	22.73	22.81
MEAN WATER CONTENT CUMULATIVE ASW	3	13.29	13.67	16.58	17.90	21.21	21.11	22.86	23.04	23.14	24.39
		13.23	13.58	13.85	16.02	20.54	21.15	21.03	21.34	21.76	22.43
		4.8	10.2	21.8	39.8	71.4	104.9	138.0	172.0	207.3	244.6
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	12.86	13.21	14.37	15.87	20.20	21.86	21.62	20.85	21.96	23.38
	2	13.25	15.51	13.50	16.37	20.66	21.35	22.12	22.79	22.10	22.60
BETWEEN ROWS	3	13.02	14.69	12.58	14.57	20.57	21.52	22.80	22.72	22.47	21.45
	1	12.44	12.60	12.73	14.10	19.64	22.39	21.95	21.32	21.13	21.52
	2	13.47	13.29	12.32	16.88	18.77	20.63	21.93	22.44	22.95	22.35
MEAN WATER CONTENT CUMULATIVE ASW	3	14.34	14.31	12.77	15.76	19.77	22.15	21.61	22.28	22.82	22.43
		13.19	14.04	13.13	15.59	20.04	21.64	22.04	22.08	22.23	22.33
		4.8	10.9	20.3	37.0	67.2	102.1	138.2	174.4	211.1	248.1
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	28.76	27.55	27.21	27.20	28.85	27.96	26.89	42.52	24.21	23.42
	2	29.85	28.90	28.55	26.54	25.97	23.18	22.42	23.24	23.19	22.63
BETWEEN ROWS	3	31.97	33.04	32.11	28.19	24.05	21.75	25.09	21.93	21.80	22.35
	1	27.72	26.66	25.95	24.64	24.06	23.21	21.10	20.00	21.03	21.20
	2	30.60	29.54	28.96	27.27	26.79	23.99	23.19	23.21	23.25	21.56
MEAN WATER CONTENT CUMULATIVE ASW	3	31.37	30.99	30.99	27.92	23.91	22.76	24.77	20.01	21.12	23.89
		30.07	29.52	29.03	27.03	25.74	23.90	24.09	25.97	22.56	22.57
		30.1	59.4	116.5	167.6	214.8	256.5	298.8	346.7	384.3	422.0
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	28.81	29.22	28.31	28.06	26.79	25.48	24.83	23.67	23.29	22.12
	2	30.70	29.57	26.39	21.35	20.70	20.31	24.07	20.88	21.64	22.50
BETWEEN ROWS	3	32.67	33.77	32.67	30.29	28.05	26.01	25.24	24.66	23.48	23.14
	1	28.75	28.40	28.02	27.82	27.38	26.55	24.11	23.36	23.12	23.77
	2	30.79	31.07	30.98	30.68	24.52	21.01	24.24	22.69	21.51	21.53
MEAN WATER CONTENT CUMULATIVE ASW	3	32.73	34.26	26.88	28.80	28.27	26.22	27.22	27.74	24.12	23.71
		30.74	31.01	28.92	27.58	25.80	24.20	24.90	23.68	22.85	22.75
		31.1	62.6	119.4	172.1	219.5	262.1	306.8	347.9	386.4	424.7
JULY 27 1979. DAYS AFTER PLANTING = 73											
		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	18.54	15.64	15.38	14.25	17.29	21.58	21.51	21.31	21.21	23.38
	2	18.41	14.92	14.83	14.07	17.85	20.36	20.88	20.55	21.67	22.76
BETWEEN ROWS	3	18.47	15.92	14.92	16.35	17.01	21.13	23.28	24.11	23.27	24.85
	1	17.19	15.40	14.53	15.32	20.71	21.40	22.13	21.55	22.44	23.47
	2	15.38	15.13	15.95	16.55	18.86	20.86	22.21	22.04	22.49	22.62
MEAN WATER CONTENT CUMULATIVE ASW	3	14.88	13.78	15.27	15.28	18.87	21.70	24.05	24.14	24.01	24.54
		17.54	15.20	15.21	15.22	18.16	21.14	22.25	22.23	22.42	23.62
		11.3	19.1	34.8	50.4	74.9	108.3	145.1	181.8	219.0	259.9
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	16.39	13.60	15.08	13.73	17.12	20.30	21.70	20.59	23.39	23.09
	2	17.98	14.69	13.51	14.91	18.40	21.40	23.05	23.77	24.32	23.76
BETWEEN ROWS	3	17.89	15.66	14.15	15.87	18.22	21.35	22.69	24.00	22.80	23.08
	1	15.77	14.07	14.74	14.30	18.15	20.55	21.91	22.37	22.08	22.12
	2	17.38	15.25	14.01	14.12	18.97	21.73	22.58	24.16	24.91	22.96
MEAN WATER CONTENT CUMULATIVE ASW	3	19.32	16.49	15.35	16.49	19.28	21.28	23.45	24.98	22.96	23.35
		17.45	14.90	14.43	14.89	18.27	21.08	22.55	23.21	23.43	23.11
		11.2	18.5	31.8	46.5	71.3	104.5	142.2	181.8	222.1	261.4
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	23.97	25.76	23.94	24.30	23.73	26.21	24.87	23.90	23.93	23.63
	2	20.64	24.17	21.95	23.28	26.68	24.43	23.18	24.23	23.98	23.24
BETWEEN ROWS	3	25.73	28.57	27.48	26.83	27.12	26.55	25.74	25.43	22.99	22.66
	1	24.42	25.17	23.58	24.88	26.20	25.76	24.54	24.66	23.92	23.75
	2	21.54	22.44	22.64	24.72	25.75	25.67	24.19	24.68	23.92	21.76
MEAN WATER CONTENT CUMULATIVE ASW	3	24.01	27.49	27.10	26.08	26.95	27.10	27.11	25.90	23.94	22.03
		23.40	25.71	24.45	24.97	26.02	25.91	24.74	23.75	23.75	22.91
		20.1	43.7	87.0	131.9	180.0	227.7	272.3	316.6	357.8	396.6
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	20.07	22.09	22.55	23.97	24.00	23.53	23.59	22.82	21.55	22.34
	2	22.36	24.91	23.97	24.33	24.49	25.80	25.72	24.41	23.74	22.74
BETWEEN ROWS	3	24.02	28.17	26.49	25.22	25.78	25.76	25.24	24.79	23.77	23.23
	1	20.73	20.13	22.71	25.18	25.67	27.14	26.10	33.61	23.53	23.83
	2	24.58	27.49	25.79	26.54	25.24	27.19	26.88	25.46	25.05	24.37
MEAN WATER CONTENT CUMULATIVE ASW	3	24.25	27.56	26.40	26.25	25.78	26.11	24.35	26.00	24.07	23.06
		22.56	25.06	24.59	25.10	25.08	25.74	25.22	25.75	23.50	23.16
		18.8	41.4	85.2	130.5	175.7	223.0	268.6	315.9	356.4	395.9

TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE. DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

JULY 31 1979. DAYS AFTER PLANTING = 77

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	19.60	12.90	12.30	12.25	14.24	19.10	20.03	20.29	20.89	22.13
	2	17.75	12.46	12.92	12.60	15.36	18.32	19.45	19.98	21.20	22.21
BETWEEN ROWS	1	18.65	13.17	13.38	13.17	17.53	20.54	21.03	21.08	20.55	19.86
	2	17.24	12.44	11.84	12.83	17.03	20.37	21.03	21.16	22.41	23.34
	3	17.18	12.43	11.43	14.40	16.25	19.96	21.42	22.31	22.28	22.73
MEAN WATER CONTENT		18.23	12.58	12.29	13.07	15.54	19.32	20.64	21.09	21.51	22.20
CUMULATIVE ASW		12.3	16.2	23.1	32.3	48.9	76.8	108.8	142.1	176.6	213.2
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	16.55	12.22	11.87	12.13	14.45	18.16	20.52	21.02	22.23	23.29
	2	17.70	11.78	12.79	13.02	15.26	19.12	21.50	21.24	22.25	23.59
BETWEEN ROWS	1	17.13	11.68	11.95	11.96	13.86	18.82	20.15	20.78	21.32	22.78
	2	15.86	12.16	10.37	12.22	12.77	17.95	20.37	22.34	21.88	23.89
	3	21.41	14.01	12.76	11.85	15.22	18.71	20.68	21.67	22.78	22.17
MEAN WATER CONTENT		17.87	12.68	12.19	12.23	14.49	18.59	20.61	21.60	22.35	22.90
CUMULATIVE ASW		11.8	15.8	22.4	29.1	42.6	68.3	100.2	135.0	172.0	210.7
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	24.94	21.88	21.84	21.05	22.39	22.95	22.92	21.80	22.45	23.03
	2	29.00	25.74	22.39	22.50	26.15	26.02	25.75	26.25	26.61	24.89
BETWEEN ROWS	1	23.26	19.95	21.50	21.24	22.20	22.17	22.39	21.95	22.61	23.42
	2	26.45	23.50	22.04	22.65	26.12	25.67	25.29	26.17	26.32	24.80
	3	29.22	28.69	28.33	26.28	25.69	26.17	25.83	27.04	26.20	25.36
MEAN WATER CONTENT		27.64	25.09	24.09	23.51	24.96	25.14	25.46	24.95	24.99	24.39
CUMULATIVE ASW		26.5	49.1	91.4	131.9	176.8	222.2	268.6	313.4	358.4	401.5
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	25.63	24.98	22.99	21.88	25.55	27.43	28.02	27.56	26.23	26.07
	2	29.87	28.42	24.68	24.74	24.69	26.38	27.51	24.94	23.56	24.05
BETWEEN ROWS	1	31.38	30.16	23.45	26.55	27.01	26.71	27.74	26.24	26.59	26.38
	2	27.12	24.33	22.61	26.17	25.53	26.41	26.99	28.26	25.84	25.89
	3	29.75	27.33	24.51	24.12	24.94	27.75	26.65	24.71	24.08	23.71
MEAN WATER CONTENT		31.10	30.06	29.42	28.06	28.82	30.40	31.30	26.53	28.65	27.11
CUMULATIVE ASW		29.11	27.61	24.43	25.08	26.02	27.38	27.98	26.35	25.75	25.53
		28.7	55.1	98.4	143.6	191.7	243.8	297.7	346.8	394.0	440.6
AUGUST 3 1979. DAYS AFTER PLANTING = 80											
		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	13.82	12.46	12.05	11.67	13.08	16.75	19.20	19.19	19.74	20.42
	2	18.39	13.19	12.11	12.31	13.47	16.61	19.00	19.91	21.09	19.88
BETWEEN ROWS	1	13.68	13.03	12.45	12.65	12.86	17.84	20.27	22.30	21.65	22.72
	2	12.65	11.43	12.19	11.48	14.65	17.95	19.46	19.56	19.17	20.62
	3	12.99	12.68	11.24	12.06	13.46	17.47	19.11	19.21	21.56	20.75
MEAN WATER CONTENT		14.75	12.45	11.72	14.36	15.25	18.35	21.52	23.00	21.88	21.83
CUMULATIVE ASW		14.56	12.61	12.01	12.38	13.66	17.41	19.71	20.52	20.84	21.03
		6.8	10.8	16.8	23.9	34.9	57.1	86.3	117.8	150.3	183.4
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	12.93	12.01	10.99	10.89	15.42	17.18	19.86	20.11	20.27	21.35
	2	12.22	11.13	11.18	12.10	13.82	16.87	19.91	20.80	21.73	21.12
BETWEEN ROWS	1	15.33	13.89	13.10	12.52	14.35	19.27	20.36	21.92	22.73	21.64
	2	13.02	11.91	11.71	12.30	13.17	17.09	20.64	18.48	21.79	21.95
	3	13.48	12.31	11.92	12.21	13.02	17.36	18.81	20.40	22.44	21.82
MEAN WATER CONTENT		15.96	14.65	13.90	13.22	13.77	18.74	20.33	21.46	21.27	22.59
CUMULATIVE ASW		13.76	12.59	12.06	12.13	14.04	17.76	19.99	20.61	21.68	21.67
		5.6	9.5	15.7	22.1	34.2	57.5	87.5	119.3	154.4	189.4
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	18.19	20.82	19.77	21.40	23.78	23.14	23.91	22.68	23.21	22.55
	2	22.84	23.80	21.88	21.74	23.21	25.24	22.97	23.32	23.94	23.91
BETWEEN ROWS	1	25.60	27.32	26.75	24.82	24.12	24.46	26.38	25.55	24.56	24.23
	2	19.52	20.08	18.48	20.64	23.15	23.89	23.30	22.39	23.16	21.58
	3	21.75	22.24	21.48	21.72	23.45	26.10	23.53	23.40	23.74	24.41
MEAN WATER CONTENT		25.68	27.18	25.93	23.86	23.43	26.06	28.06	24.13	24.59	24.02
CUMULATIVE ASW		22.25	23.66	22.46	22.42	23.56	24.71	24.64	23.63	23.87	23.47
		18.4	38.9	76.3	113.5	154.2	198.3	242.2	283.1	324.7	365.2
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	18.48	20.23	20.79	22.89	25.88	25.15	25.58	25.83	24.90	23.52
	2	24.52	25.37	24.34	24.76	24.42	25.21	27.63	25.49	24.95	24.40
BETWEEN ROWS	1	24.81	25.24	25.05	23.60	23.28	23.96	25.08	23.24	23.59	23.34
	2	19.41	22.79	20.61	22.03	24.38	24.98	24.68	25.09	25.33	24.48
	3	24.75	24.23	24.33	25.95	27.25	25.40	26.32	25.43	24.60	24.61
MEAN WATER CONTENT		24.30	27.35	25.69	23.60	24.46	24.30	25.14	24.36	24.23	24.29
CUMULATIVE ASW		22.69	24.08	23.45	23.79	24.86	24.82	25.81	24.89	24.57	24.04
		19.0	40.2	80.5	121.9	166.5	210.9	258.4	303.1	346.8	388.9



TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE. DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

AUGUST 8 1979. DAYS AFTER PLANTING = 85

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	10.40	11.15	10.67	10.81	12.15	14.12	17.62	18.73	18.83	20.17
	2	11.06	11.48	10.70	10.97	11.14	15.28	18.47	19.86	20.86	20.69
BETWEEN ROWS	1	11.02	10.33	11.52	10.73	12.89	17.59	18.77	18.73	18.80	18.93
	2	11.83	10.80	11.23	11.46	13.87	16.03	18.78	20.18	20.48	20.82
	3	10.07	10.32	10.64	10.98	13.55	17.03	19.70	21.02	21.34	22.35
MEAN WATER CONTENT		10.97	10.80	10.90	11.16	12.23	15.89	18.42	19.98	20.12	20.67
CUMULATIVE ASW		1.5	2.7	5.4	8.8	15.5	33.2	58.4	88.4	118.8	150.8
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	10.99	11.29	10.52	10.65	11.73	15.00	17.77	18.63	19.68	21.35
	2	11.06	8.60	10.22	10.58	12.65	15.95	18.69	20.33	21.23	20.42
BETWEEN ROWS	1	12.15	11.43	10.50	10.96	12.99	16.92	17.98	18.22	20.43	20.80
	2	11.27	11.49	10.76	11.59	12.41	17.54	18.45	20.09	21.77	20.74
	3	12.32	11.83	11.87	11.28	13.68	16.07	19.26	20.13	21.29	21.36
MEAN WATER CONTENT		11.58	11.03	10.83	11.01	12.73	16.24	18.59	19.77	20.91	20.96
CUMULATIVE ASW		2.4	3.9	6.4	9.4	17.6	36.4	62.1	91.4	124.2	157.1
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	15.52	16.18	17.24	17.86	20.95	22.97	23.69	22.58	23.98	24.35
	2	19.92	20.48	18.83	18.49	19.97	24.26	22.73	22.83	23.43	23.55
BETWEEN ROWS	1	15.09	15.70	17.01	15.17	20.20	22.42	22.97	22.52	23.89	24.61
	2	18.77	17.20	17.73	18.80	21.30	22.48	22.15	23.20	23.09	23.47
	3	21.03	23.06	22.36	21.36	22.24	24.21	26.65	22.72	23.49	25.06
MEAN WATER CONTENT		18.10	19.80	19.60	18.89	21.26	23.33	24.31	22.93	23.63	24.19
CUMULATIVE ASW		12.2	26.9	55.7	82.3	116.1	156.1	199.1	237.9	278.7	321.3
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	16.06	16.36	16.51	20.92	21.35	24.26	24.07	25.53	24.58	25.62
	2	20.52	20.51	19.22	19.38	20.73	23.60	23.50	22.41	22.63	21.91
BETWEEN ROWS	1	15.77	16.62	17.41	21.57	22.63	24.13	25.71	25.61	24.46	25.29
	2	19.84	21.90	18.83	18.97	19.78	23.09	23.38	22.79	22.68	23.00
	3	22.19	23.55	23.64	21.83	22.69	25.85	24.17	24.30	24.67	24.71
MEAN WATER CONTENT		18.99	20.29	19.71	20.49	20.97	22.47	24.64	24.48	23.88	24.06
CUMULATIVE ASW		13.5	28.9	58.0	89.5	122.4	159.9	203.8	247.2	288.9	331.0
AUGUST 14 1979. DAYS AFTER PLANTING = 91											
		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	11.58	12.02	10.96	11.17	11.09	13.04	16.66	18.49	19.83	20.12
	2	11.92	11.44	11.92	11.11	11.27	13.28	17.82	18.97	20.49	20.28
BETWEEN ROWS	1	11.32	12.19	11.47	10.44	12.26	15.71	18.46	18.30	20.08	21.36
	2	11.47	11.83	11.14	11.07	12.15	15.47	17.73	19.27	21.31	22.00
	3	10.10	10.46	11.18	10.57	11.78	15.55	18.74	19.72	21.08	24.13
MEAN WATER CONTENT		11.16	11.40	11.42	10.91	11.55	14.13	17.87	19.06	20.63	21.55
CUMULATIVE ASW		1.7	3.8	8.1	10.8	15.5	27.9	51.5	78.7	110.6	145.2
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	10.87	10.78	10.85	10.52	11.79	14.38	16.98	18.08	19.32	21.90
	2	11.18	10.57	10.25	10.78	11.08	13.46	17.83	20.34	22.07	22.74
BETWEEN ROWS	1	11.62	10.75	11.56	11.19	12.08	14.08	19.38	19.13	20.08	22.35
	2	11.00	11.40	10.81	10.82	10.90	13.47	17.34	20.01	22.07	21.81
	3	12.07	12.57	11.72	11.53	12.19	14.22	18.83	19.98	20.93	21.31
MEAN WATER CONTENT		11.38	11.30	11.05	10.84	11.94	13.96	18.06	19.81	20.97	21.95
CUMULATIVE ASW		2.1	4.0	7.2	9.7	15.5	27.4	51.6	81.0	113.9	149.7
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	19.67	21.42	16.94	15.65	18.70	20.13	20.49	21.64	20.82	21.27
	2	26.55	24.41	21.72	19.90	22.75	23.15	22.97	22.82	23.40	24.74
BETWEEN ROWS	1	21.13	16.34	14.01	14.56	17.11	19.38	19.00	19.64	20.66	19.78
	2	25.00	23.46	18.96	17.88	20.15	22.47	22.58	22.28	23.27	24.34
	3	29.05	29.90	29.26	25.02	23.15	24.24	27.60	23.83	23.41	24.60
MEAN WATER CONTENT		25.20	24.47	21.89	19.64	20.85	22.16	23.26	22.40	22.45	23.36
CUMULATIVE ASW		22.8	44.5	80.2	109.1	141.6	178.1	217.9	255.1	292.5	332.6
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	24.48	23.86	21.72	20.51	22.47	22.71	24.18	24.98	25.59	24.16
	2	25.80	24.17	19.43	20.11	21.32	22.57	26.39	24.08	24.87	24.61
BETWEEN ROWS	1	23.67	25.73	23.10	22.42	24.55	24.03	24.56	24.71	25.17	23.86
	2	25.03	25.43	23.00	20.58	21.34	21.86	27.44	25.57	24.10	24.53
	3	30.11	30.28	29.26	25.34	24.67	25.94	29.02	25.41	26.01	26.39
MEAN WATER CONTENT		26.42	26.28	23.41	21.62	22.78	23.62	26.51	25.01	25.21	25.02
CUMULATIVE ASW		24.6	49.1	89.3	124.2	162.5	203.3	252.9	297.9	343.5	388.6

TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE. DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

AUGUST 20 1979. DAYS AFTER PLANTING = 97

							DEPTH (M)				
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	10.56	11.04	10.40	10.55	10.85	11.79	15.41	18.09	20.00	20.34
	2	10.32	10.34	10.25	10.49	10.75	11.29	16.52	20.20	19.28	19.82
BETWEEN ROWS	3	10.85	11.80	10.77	10.94	11.55	13.20	17.11	19.68	20.55	20.32
	1	10.01	10.40	10.21	10.34	10.51	11.97	15.22	17.16	19.87	20.77
	2	9.89	10.01	10.28	10.57	11.06	12.68	18.22	20.95	20.07	20.27
MEAN WATER CONTENT	3	10.67	11.49	10.02	10.21	11.33	12.79	18.18	19.24	19.73	20.44
		10.42	10.89	10.35	10.55	11.02	12.25	16.69	19.24	19.92	20.29
	CUMULATIVE ASW	0.6	2.0	3.0	4.7	7.7	14.4	34.5	62.2	92.0	122.9
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	9.70	10.91	9.98	10.23	10.76	11.75	14.71	17.09	19.42	19.83
	2	10.05	10.68	9.98	10.71	10.82	12.28	15.83	20.60	20.93	20.71
BETWEEN ROWS	3	11.46	11.60	10.15	11.03	11.35	11.78	17.04	19.71	20.40	21.12
	1	10.15	10.63	9.64	10.30	10.66	11.32	14.97	17.90	20.48	19.97
	2	10.05	10.27	10.27	11.08	11.38	13.06	16.15	21.30	21.86	21.20
MEAN WATER CONTENT	3	11.04	11.84	10.76	10.83	12.31	12.29	16.63	19.70	19.62	20.34
		10.41	11.00	10.13	10.69	11.17	12.05	15.88	19.33	20.41	20.53
	CUMULATIVE ASW	0.6	2.1	6.8	8.9	12.4	18.5	36.2	64.2	95.4	127.0
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	17.34	18.33	17.60	14.82	17.04	19.13	21.12	20.42	20.94	21.98
	2	20.04	21.16	18.13	18.08	18.74	23.76	22.17	22.03	23.22	23.30
BETWEEN ROWS	3	22.44	27.18	25.06	21.85	20.74	21.83	25.78	23.57	22.71	23.12
	1	15.72	15.24	14.27	14.17	17.27	19.06	19.84	19.80	20.41	20.83
	2	19.93	21.17	17.76	16.51	18.27	22.40	21.13	21.67	22.82	23.74
MEAN WATER CONTENT	3	25.83	26.79	25.05	20.58	20.28	21.79	24.39	22.95	21.76	22.72
		20.16	21.76	19.77	17.70	18.75	21.38	22.53	21.79	22.04	22.65
	CUMULATIVE ASW	15.2	32.9	62.2	85.3	111.5	145.7	183.3	218.6	254.8	292.7
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	20.02	22.03	20.43	20.70	23.96	22.29	22.05	23.91	23.89	23.62
	2	20.87	21.36	17.80	17.74	18.19	23.68	24.42	21.69	21.96	22.30
BETWEEN ROWS	3	24.26	26.32	26.55	21.99	20.70	21.72	25.86	25.19	24.65	24.92
	1	19.41	21.32	21.07	21.46	22.50	23.39	23.06	24.00	23.48	22.00
	2	22.15	22.49	19.35	18.41	19.39	24.12	24.09	22.72	21.82	22.23
MEAN WATER CONTENT	3	22.47	24.39	23.01	19.54	19.90	21.80	24.71	24.10	23.47	23.75
		21.57	23.04	21.42	20.01	20.81	22.78	24.04	23.60	23.27	23.35
	CUMULATIVE ASW	17.4	36.9	71.2	101.2	133.6	171.9	214.1	254.9	294.7	334.7

AUGUST 24 1979. DAYS AFTER PLANTING = 101

							DEPTH (M)				
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	22.97	12.22	11.71	10.93	11.01	12.36	15.81	18.32	19.68	20.37
	2	24.22	13.46	11.13	11.34	11.72	12.09	16.15	20.32	20.44	20.40
BETWEEN ROWS	3	23.01	12.15	13.11	11.37	11.80	14.16	19.14	20.73	22.16	22.88
	1	23.91	11.15	11.56	10.28	11.17	13.72	18.08	18.15	19.06	20.56
	2	22.88	11.94	10.97	11.34	11.68	12.83	16.01	20.16	21.67	21.37
MEAN WATER CONTENT	3	21.17	12.60	12.89	11.53	12.54	15.55	19.55	20.57	22.16	22.89
		23.10	12.33	11.92	11.15	11.62	13.34	17.37	19.72	20.84	21.37
	CUMULATIVE ASW	19.7	23.1	28.9	32.3	37.2	47.2	69.3	98.5	131.0	165.1
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	22.77	18.58	10.38	10.71	11.31	12.20	16.12	19.71	20.66	22.19
	2	23.33	12.29	10.67	10.98	11.72	12.25	16.73	20.09	19.97	20.73
BETWEEN ROWS	3	25.83	13.84	12.67	11.69	13.30	13.49	18.52	20.71	22.24	21.58
	1	23.76	16.03	11.01	11.04	11.22	12.85	17.90	19.37	20.57	22.28
	2	21.10	11.28	11.00	11.63	12.15	13.09	17.40	21.15	20.57	21.63
MEAN WATER CONTENT	3	25.44	15.87	12.55	11.17	13.07	14.78	18.79	20.84	22.29	22.28
		23.76	14.70	11.35	11.19	12.13	13.02	17.49	20.28	21.03	21.72
	CUMULATIVE ASW	20.6	27.7	31.7	35.3	41.7	50.7	73.2	104.1	137.1	172.3
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	25.18	19.78	13.81	13.72	15.80	18.53	18.37	18.84	20.58	20.35
	2	30.29	24.86	19.44	17.79	21.67	21.96	22.68	23.99	24.26	23.70
BETWEEN ROWS	3	33.37	32.22	30.96	26.05	23.43	23.96	25.21	25.09	24.11	23.74
	1	24.38	19.72	15.41	14.58	16.30	19.32	18.25	19.02	20.07	19.24
	2	28.06	20.49	16.26	16.03	22.17	21.42	22.00	22.95	23.13	22.58
MEAN WATER CONTENT	3	32.47	30.60	28.62	23.41	22.92	23.54	26.41	23.83	22.90	23.23
		29.09	24.81	20.88	18.71	20.37	21.46	22.14	22.36	22.60	22.23
	CUMULATIVE ASW	28.6	50.9	83.5	109.6	140.7	175.1	211.5	248.6	286.4	323.1
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	28.45	22.78	17.36	18.93	20.79	22.33	24.12	24.36	24.29	23.82
	2	31.89	30.36	26.21	23.64	22.02	23.49	24.85	23.28	22.56	24.29
BETWEEN ROWS	3	33.81	31.71	28.26	21.99	22.63	23.96	26.35	25.25	24.86	26.09
	1	28.10	24.09	17.96	18.05	21.27	22.66	23.79	23.84	24.30	24.53
	2	31.97	30.85	25.07	22.06	22.23	23.57	23.54	22.75	23.27	22.79
MEAN WATER CONTENT	3	34.28	31.23	26.14	21.39	22.09	23.11	27.19	25.05	25.51	26.70
		31.41	28.46	23.59	21.11	21.83	23.20	25.00	24.13	24.08	24.71
	CUMULATIVE ASW	32.1	59.8	100.6	133.9	169.4	209.0	254.0	296.4	338.7	382.8

TABLE 13.—VOLUMETRIC SOIL WATER CONTENTS (PERCENT) AND CUMULATIVE ASW LEVELS (MM) FOR N100, N25, I100, AND I25, RESPECTIVELY, FOR SAMPLING DATE. DEPTH INCREMENTS 0.15 M TO 0.30 M AND 0.305 M TO 2.74 M—CONTINUED

AUGUST 29 1979. DAYS AFTER PLANTING = 106

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	25.63	23.76	16.72	10.33	10.78	11.99	14.84	18.83	20.07	22.44
	2	24.38	23.30	16.72	12.21	11.48	11.33	14.90	18.87	20.16	21.56
BETWEEN ROWS	1	24.84	19.71	11.39	10.78	10.96	12.66	17.31	17.92	19.96	21.26
	2	24.19	19.73	11.25	11.69	11.87	13.08	17.26	19.72	20.95	21.11
	3	24.64	21.43	11.32	12.39	12.21	14.06	18.24	20.19	20.96	21.50
MEAN WATER CONTENT		24.91	22.37	14.51	11.48	11.40	12.42	16.57	19.36	20.41	21.84
CUMULATIVE ASW		22.4	40.9	54.4	58.9	63.1	70.3	90.0	118.1	149.3	184.8
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	24.86	23.63	13.10	10.98	11.38	13.24	17.43	19.71	21.02	22.60
	2	24.38	23.30	16.72	12.21	11.48	11.33	14.90	18.87	20.16	21.56
BETWEEN ROWS	1	24.26	22.58	12.74	10.71	12.15	12.52	17.60	19.18	21.86	22.93
	2	24.19	19.73	11.25	11.69	11.87	13.08	17.26	19.72	20.95	21.11
	3	26.18	23.74	12.14	10.97	12.56	13.40	18.19	21.49	22.33	21.50
MEAN WATER CONTENT		25.26	23.49	14.53	11.50	11.74	12.92	17.27	19.85	21.18	22.07
CUMULATIVE ASW		22.9	43.1	56.7	61.2	66.4	75.2	97.0	126.5	160.1	196.3
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	27.31	26.77	26.24	22.09	21.33	22.50	24.00	23.38	23.78	24.44
	2	27.85	28.63	25.51	21.18	18.72	23.78	23.05	22.03	23.48	23.71
BETWEEN ROWS	1	27.16	26.40	25.54	24.06	22.82	23.71	23.94	23.53	24.08	25.30
	2	28.67	25.41	20.91	15.86	17.17	21.80	25.54	21.52	21.88	23.91
	3	31.24	31.07	30.93	27.28	23.85	22.32	27.24	23.39	23.37	24.14
MEAN WATER CONTENT		29.06	28.40	27.02	23.29	21.39	22.85	24.39	22.71	23.33	24.11
CUMULATIVE ASW		28.6	56.2	107.3	147.1	181.3	219.9	263.0	301.2	341.1	383.5
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	27.98	26.97	24.08	23.33	21.72	22.18	23.36	23.87	24.26	23.47
	2	30.09	30.83	31.04	26.61	23.66	23.02	26.36	23.57	23.81	24.56
BETWEEN ROWS	1	30.87	31.24	30.13	21.99	20.18	19.77	27.58	23.45	24.55	25.81
	2	27.55	26.59	24.58	25.03	22.35	22.50	24.16	25.02	23.53	24.26
	3	30.63	31.16	29.29	29.35	25.26	22.50	34.74	24.72	23.97	24.70
MEAN WATER CONTENT		29.87	29.71	28.27	24.71	22.23	22.03	26.64	24.01	24.13	24.71
CUMULATIVE ASW		29.8	59.4	114.2	158.3	195.0	231.1	281.0	323.1	365.5	409.6

SEPT 10 1979. DAYS AFTER PLANTING = 117

		DEPTH (M)									
		0.15	0.30	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74
NONIRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	24.37	23.65	19.12	11.76	11.85	12.01	14.83	16.89	20.56	20.39
	2	22.88	22.69	21.08	13.55	11.10	11.94	16.48	16.77	19.30	21.64
BETWEEN ROWS	1	26.02	24.52	22.98	15.38	11.31	12.46	17.41	20.25		
	2	22.59	21.19	13.95	11.08	11.91	12.72	17.39	16.78	20.02	22.05
	3	22.39	22.62	19.59	12.57	11.29	12.59	16.30	18.35	20.53	22.10
MEAN WATER CONTENT		24.04	23.29	19.89	12.98	11.42	12.41	16.60	18.63	20.31	21.57
CUMULATIVE ASW		21.1	41.0	70.7	79.6	83.9	91.1	110.9	136.8	175.2	217.8
NONIRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	23.07	24.22	21.07	11.75	12.11	12.32	15.31	17.90	17.92	20.25
	2	23.67	24.28	20.92	12.11	11.62	12.65	16.17	20.55	21.73	23.23
BETWEEN ROWS	1	26.48	27.03	22.13	13.45	11.87	13.35	16.38	19.28	20.83	22.22
	2	24.19	23.94	22.30	11.05	11.42	12.74	16.61	18.05	20.49	21.95
	3	23.97	24.03	20.62	11.31	11.80	12.58	16.02	21.11	21.39	21.84
MEAN WATER CONTENT		24.57	25.06	21.46	12.01	11.71	12.97	16.23	19.37	20.45	21.96
CUMULATIVE ASW		21.9	44.4	78.8	84.9	90.0	98.9	117.6	145.7	177.0	212.9
IRRIGATED 1.0M ROWS											
IN ROW	REP										
	1	24.29	25.41	22.73	20.07	20.50	21.21	24.65	20.95	22.10	23.12
	2	26.90	26.70	24.22	22.60	21.60	24.42	22.48	22.82	22.40	23.37
BETWEEN ROWS	1	28.55	30.05	29.49	25.87	21.60	20.46	25.34	23.23	23.55	23.67
	2	22.59	23.61	20.99	18.73	19.60	21.26	21.35	21.01	22.68	23.04
	3	26.01	26.70	24.17	21.48	22.76	24.06	22.08	21.94	24.31	23.48
MEAN WATER CONTENT		26.17	27.05	25.04	22.23	21.32	22.06	23.75	22.08	22.81	23.35
CUMULATIVE ASW		24.3	49.8	95.0	131.6	165.6	201.8	243.0	279.3	317.7	357.8
IRRIGATED 0.25M ROWS											
IN ROW	REP										
	1	24.74	25.13	22.99	22.65	24.26	23.06	24.00	24.92	24.79	24.60
	2	27.05	28.79	27.21	25.70	24.35	22.59	26.38	25.02	23.74	24.22
BETWEEN ROWS	1	30.63	29.61	30.56	28.98	28.48	27.70	24.16	26.10	26.24	26.45
	2	24.64	24.88	23.06	24.73	23.19	23.93	24.74	24.07	24.66	23.92
	3	27.66	29.02	27.66	26.40	24.09	22.51	26.47	25.35	23.86	24.43
MEAN WATER CONTENT		29.89	30.01	29.35	27.45	26.13	26.09	27.27	25.20	24.63	25.37
CUMULATIVE ASW		27.44	27.90	26.83	25.94	25.21	24.34	26.17	25.16	24.71	24.88
		26.2	53.0	103.5	151.3	196.9	240.0	288.5	333.9	378.1	422.7



Because of runoff from irrigation and rainfall, rates of soil water use were difficult to determine. In the nonirrigated plots, the rate of soil water use was the same for 0.25-m and 1.0-m rows, over both time and depth. This result agreed with some studies (26) but contrasts with others that show a slower rate of water use in narrow-row corn (31) and a faster rate of water use in narrow-row soybeans (24). The only measured difference between the two row spacings was in the water use midway between rows. The 1.0-m row plants used the water between the rows at a relatively slower rate than that within the plant rows. The inter- and intra-row water use rates were equal in the 0.25-m rows.

The effects of irrigation and row spacing on soybean rooting patterns are shown in tables 14 to 17. The large amount of time and crop area needed for root sampling by the framed monolith method meant that replicate samples could not be collected (2). This lack of replication is compensated for by the large volume of soil sampled, compared to other root sampling methods. Without replication, no statistical analysis can be performed on the data to validate the following observations.

Plants in the nonirrigated treatments produced more roots in the lower soil layers than those in the irrigated treatments, in agreement with other reports (4, 14, 23). Within an irrigation treatment, we found that total root length was greater at the 0.25-m row spacing, resulting in an increased root length per unit leaf area and a decreased shoot-to-root ratio (table 17). Unpublished data from the 1976 season support the observation of more roots in 0.25-m rows than in the 1.0-m rows. We are unable to select a preferred reason for this increased root growth from several possible ones, but we believe that the increased yield in the 0.25-m rows was not the result of the increased root length.

Water uptake from each of the soil layers sampled, during periods of little or no rainfall, is shown in table 18. The values are for the nonirrigated 0.25-m rows (N25) treatment, but the uptakes from the N100 treatment are very similar. Table 18 gives the apparent uptake from each layer, calculated from the changes in soil water content only. Uptake values, corrected for unsaturated flow between the soil layers, are also presented in table 18. Uptake rates per unit length of root (fig. 4) calculated for the N25 treatment show the general trend of root uptake rates declining as soil water content declines and support reports by others (25, 29). Figure 4 shows no difference between deep and shallow roots in the rate of root water uptake.

Similar results from cotton roots were used as evidence that axial resistance was not important in determining the site of root water uptake (25). Willatt and Taylor (29) found some evidence to suggest that axial resistance may be important in soybean roots, but figure 4 does not support their conclusions. However, after rainfall on day 98, essentially no water uptake occurred below the 0.9-m depth in the nonirrigated plots, despite the fact that approximately one-third of the total root length was located below that depth. Root axial resistance may have been an important factor in this preferential use of soil water in the upper section of the profile. The question about magnitudes of axial resistance in soybeans has not been resolved.

We measured evapotranspiration (ET) 5 days during the growth season from just before canopy closure to early pod fill. Statistical analysis of the average daily ET rates for each treatment is shown in table 19. The variations in wet- and dry-bulb temperatures with time for four of the sampling days are presented in figure 5. The last sampling day, August 23, is not presented because rainfall limited the sampling time to about 3 hr. ET and solar radiation values for July 10, July 11, July 31, and August 1 are presented in figures 6 to 9, respectively.

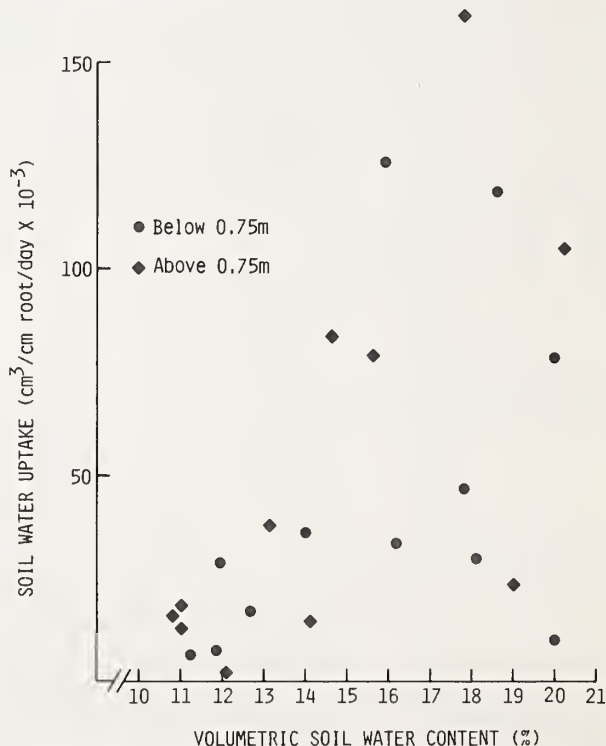


FIGURE 4.—Soil water uptake as a function of soil water content by nonirrigated 0.25-m row width soybeans.

Text continues on page 35.

TABLE 14.—ROOT LENGTH DENSITY (CM/CM<sup>3</sup>) FOR EACH DEPTH INCREMENT AT VARIOUS SAMPLING TIMES

[nonirrigated soybeans]

0.25 m rows (N25)										1 m Rows (N100)									
Depth	Date and Days After Planting								Date and Days After Planting										
	June 13	June 21	June 28	July 09	July 26	Aug. 07	Aug. 20		June 13	June 21	June 28	July 13	July 26	Aug. 07	Aug. 20				
	[29]	[37]	[44]	[55]	[72]	[84]	[97]		[29]	[37]	[44]	[59]	[72]	[84]	[97]				
m	cm/cm <sup>3</sup>																		
0	-0.075	0.07 <sup>1</sup>	0.10	0.07	0.07	0.30	0.46	0.53	0.04 <sup>1</sup>	0.07	0.04	0.21	0.34	0.52	0.32	0.30			
0.075-0.15		0.07	0.14	0.49	0.26	0.51	0.45	0.77	0.04	0.15	0.25	0.17	0.51	0.39	0.30	0.30			
0.15-0.225		0.07	0.07	0.24	0.38	0.29	0.17	0.37	0.04	0.03	0.10	0.10	0.17	0.29	0.16	0.16			
0.225-0.3		0.07	0.03	0.15	0.17	0.23	0.13	0.15	0.04	0.01	0.06	0.06	0.15	0.11	0.11	0.11			
0.3-0.375		-	0.01	0.05	0.05	0.14	0.17	0.10	-	0.01	0.01	0.06	0.18	0.11	0.11	0.11			
0.375-0.45		-	<0.01	0.04	0.07	0.15	0.12	0.13	-	0.01	0.01	0.07	0.18	0.13	0.11	0.11			
0.45-0.525		-	-	0.03	0.09	0.15	0.14	0.16	-	<0.01	0.02	0.08	0.17	0.17	0.14	0.14			
0.525-0.6		-	-	0.04	0.07	0.24	0.17	0.17	-	-	0.01	-	-	0.16	0.15	0.15			
0.6-0.75		-	-	0.02	0.06	0.15	0.17	0.15	-	-	0.01	0.05	0.17	0.15	0.14	0.14			
0.75-0.9		-	-	<0.01	0.05	0.25	0.21	0.15	-	-	<0.01	0.04	0.18	0.15	0.16	0.16			
0.9-1.05		-	-	-	0.02	0.11	0.20	0.19	-	-	-	0.03	0.17	0.18	0.16	0.16			
1.05-1.2		-	-	-	<0.01	0.06	0.24	0.19	-	-	-	0.01	0.16	0.13	0.17	0.17			
1.2-1.35		-	-	-	-	0.01	0.17	0.17	-	-	-	<0.01	0.07	0.12	0.12	0.12			
1.35-1.5		-	-	-	-	-	0.08	0.10	-	-	-	-	0.02	0.04	0.07	0.07			
1.5-1.65		-	-	-	-	-	0.03	0.06	-	-	-	-	0.01	0.02	0.01	0.01			
1.65-1.8		-	-	-	-	-	0.01	0.02	-	-	-	-	<0.01	<0.01	0.01	0.01			

<sup>1</sup> June 13 sample not divided into depth increments.

TABLE 14.—ROOT LENGTH DENSITY (CM/CM<sup>3</sup>) FOR EACH DEPTH INCREMENT AT VARIOUS SAMPLING TIMES—CONTINUED

[irrigated soybeans]														
1 m rows (I100)														
Date and Days After Planting														
	June 13 [29]	June 21 [37]	June 27 [43]	July 12 [58]	July 25 [71]	Aug. 06 [83]	Aug. 06 [83]	Aug. 20 [97]						
	0.05 <sup>1</sup>	0.10	0.04	0.09	0.34	0.53	0.63							
0	-0.075	0.09 <sup>1</sup>	0.03	0.04	0.07	0.30	0.67	0.44						
0.075-0.15		0.09	0.07	0.51	0.24	0.87	0.80	0.69						
0.15-0.225		0.09	0.14	0.40	0.42	0.31	0.16	0.36						
0.225-0.3		0.09	0.05	0.19	0.13	0.07	0.09	0.19						
0.3-0.375		-	0.01	0.05	0.04	0.07	0.06	0.14						
0.375-0.45		-	0.01	0.03	0.15	0.09	0.05	0.15						
0.45-0.525		-	<0.01	0.02	0.04	0.10	0.09	0.13						
0.525-0.6		-	-	0.02	0.05	0.10	0.14	0.15						
0.6-0.75		-	-	0.01	0.01	0.07	0.10	0.10						
0.75-0.9		-	-	<0.01	0.01	0.07	0.12	0.10						
0.9-1.05		-	-	-	<0.01	0.08	0.08	0.09						
1.05-1.2		-	-	-	-	0.09	0.08	0.09						
1.2-1.35		-	-	-	-	0.05	0.06	0.09						
1.35-1.5		-	-	-	-	0.04	0.04	0.07						
1.5-1.65		-	-	-	-	<0.01	0.03	0.05						
1.65-1.8		-	-	-	-	-	-	<0.01						

0.25 m rows (I25)														
Date and Days After Planting														
	June 13 [29]	June 21 [37]	June 27 [43]	July 12 [58]	July 25 [71]	Aug. 06 [83]	Aug. 06 [83]	Aug. 20 [97]						
	0.09 <sup>1</sup>	0.03	0.04	0.07	0.30	0.67	0.44							
0	-0.075	0.09 <sup>1</sup>	0.03	0.04	0.07	0.30	0.67	0.44						
0.075-0.15		0.09	0.07	0.51	0.24	0.87	0.80	0.69						
0.15-0.225		0.09	0.14	0.40	0.42	0.31	0.16	0.36						
0.225-0.3		0.09	0.05	0.19	0.13	0.07	0.09	0.19						
0.3-0.375		-	0.01	0.05	0.04	0.07	0.06	0.14						
0.375-0.45		-	0.01	0.03	0.15	0.09	0.05	0.15						
0.45-0.525		-	<0.01	0.02	0.04	0.10	0.09	0.13						
0.525-0.6		-	-	0.02	0.05	0.10	0.14	0.15						
0.6-0.75		-	-	0.01	0.01	0.07	0.10	0.10						
0.75-0.9		-	-	<0.01	0.01	0.07	0.12	0.10						
0.9-1.05		-	-	-	<0.01	0.08	0.08	0.09						
1.05-1.2		-	-	-	-	0.09	0.08	0.09						
1.2-1.35		-	-	-	-	0.05	0.06	0.09						
1.35-1.5		-	-	-	-	0.04	0.04	0.07						
1.5-1.65		-	-	-	-	<0.01	0.03	0.05						
1.65-1.8		-	-	-	-	-	-	<0.01						

<sup>1</sup> June 13 sample not divided into depth increments.

TABLE 15.—ROOT DRY MASS PER UNIT GROUND SURFACE AREA (G/M<sup>2</sup>) FOR VARIOUS DEPTHS AND SAMPLING TIMES  
[nonirrigated soybeans]

0.25 m rows (N25)										1 m rows (N100)									
Depth	Date and Days After Planting								m	Date and Days After Planting									
	June 13 [29]	June 21 [37]	June 28 [44]	July 09 [55]	July 26 [72]	Aug. 07 [84]	Aug. 20 [97]	June 13 [29]		June 21 [37]	June 28 [44]	July 13 [59]	July 26 [72]	Aug. 07 [84]	Aug. 20 [97]				
0	-0.075	3.67	6.24	5.44	26.42	38.91	40.11												
0.075-0.15	4.80 <sup>1</sup>	1.55	3.53	10.57	8.91	9.62	14.02		2.24 <sup>1</sup>	1.17	2.08	2.83	6.05	7.58	5.71				
0.15 -0.225		0.73	2.17	4.44	3.66	2.81	8.52			0.25	0.94	1.26	2.33	4.46	2.76				
0.225-0.3		0.35	1.00	1.96	2.41	1.84	3.89			0.07	0.57	0.69	1.61	1.79	1.35				
0.3 -0.375	-	0.11	0.37	0.81	1.83	2.16	2.19		-	0.06	0.16	0.67	1.52	1.25	1.21				
0.375-0.45	-	0.02	0.37	0.83	1.74	2.09	2.41		-	0.9	0.16	0.69	1.70	1.41	1.06				
0.45 -0.525	-	-	0.30	0.94	1.89	1.85	2.47		-	0.04	0.15	0.76	1.59	1.62	1.31				
0.525-0.6	-	-	0.36	0.84	2.15	2.09	2.37		-	-	0.13	-	-	1.37	1.52				
0.6 -0.75	-	-	0.43	1.74	3.84	3.54	4.20		-	-	0.2	1.48	3.06	2.74	3.13				
0.75 -0.9	-	-	0.06	1.27	4.14	3.91	3.96		-	-	0.06	0.81	3.23	2.95	3.56				
0.9 -1.05	-	-	-	0.61	1.84	4.00	4.43		-	-	-	0.60	3.70	3.07	3.56				
1.05 -1.2	-	-	-	0.15	0.87	4.32	3.59		-	-	-	0.19	2.33	2.89	3.72				
1.2 -1.35	-	-	-	0.01	0.18	3.35	2.80		-	-	-	0.05	0.91	1.98	2.28				
1.35 -1.5	-	-	-	-	-	1.44	1.96		-	-	-	-	0.35	0.37	1.16				
1.5 -1.65	-	-	-	-	-	0.55	0.89		-	-	-	-	0.11	0.09	0.17				
1.65 -1.8	-	-	-	-	-	0.19	0.21		-	-	-	-	0.06	-	0.17				
Loose	-	0.42	0.32	0.60	0.26	0.84	0.98		-	0.16	0.03	0.51	0.28	0.76	2.15				
TOTAL	4.80	6.85	15.16	30.22	60.15	83.51	99.00		2.24	5.35	9.15	33.96	66.75	68.23	66.72				

<sup>1</sup> June 13 sample not divided into depth increments.

TABLE 15.—ROOT DRY MASS PER UNIT GROUND SURFACE AREA (G/M<sup>2</sup>) FOR VARIOUS DEPTHS AND SAMPLING TIMES—CONTINUED  
[irrigated soybeans]

0.25 m rows (125)										1 m rows (1100)									
Depth	Date and Days After Planting								Date and Days After Planting										
	June 13	June 21	June 27	July 12	July 25	Aug. 06	Aug. 20		June 13	June 21	June 27	July 12	July 25	Aug. 06	Aug. 20				
	[29]	[37]	[43]	[58]	[71]	[83]	[97]		[29]	[37]	[43]	[58]	[71]	[83]	[97]				
m										g/m <sup>2</sup>									
0 -0.075		1.97	4.97	8.04	32.75	34.30	38.72			2.65	5.48	11.7	23.78	32.70	39.03				
0.075-0.15	6.34 <sup>1</sup>	1.00	3.45	13.35	5.65	11.36	10.40		3.24 <sup>1</sup>	0.59	2.45	5.10	4.09	10.80	10.49				
0.15 -0.225		1.34	2.72	4.13	2.18	2.39	5.25			0.32	1.33	1.24	2.28	2.69	4.28				
0.225-0.3		0.42	1.42	1.39	0.68	0.74	2.24			0.07	0.36	0.62	1.02	0.74	1.84				
0.3 -0.375	-	0.13	0.39	0.64	0.65	0.45	1.28		-	0.05	0.23	0.37	0.60	0.57	0.91				
0.375-0.45	-	0.06	0.22	0.71	0.74	0.43	1.38		-	0.02	0.17	0.17	0.46	0.68	0.71				
0.45 -0.525	-	0.03	0.20	0.54	0.86	0.69	1.09		-		0.12	0.22	0.37	0.61	0.59				
0.525-0.6	-	-	0.18	0.52	0.90	0.82	1.30		-	-	0.07	0.34	0.43	0.50	0.67				
0.6 -0.75	-	-	0.25	1.37	1.45	1.49	2.34		-	-	0.19	0.29	0.59	0.85	1.20				
0.75 -0.9	-	-	0.07	0.52	1.35	1.78	1.82		-	-	0.05	0.24	0.58	0.16	1.11				
0.9 -1.05	-	-	-	0.16	1.27	1.33	1.82		-	-	-	0.14	0.33	1.50	1.40				
1.05 -1.2	-	-	-	-	1.21	1.21	1.32		-	-	-	0.02	0.23	1.74	1.43				
1.2 -1.35	-	-	-	-	0.61	0.75	1.36		-	-	-	-	0.23	0.87	0.78				
1.35 -1.5	-	-	-	-	0.04	0.51	1.30		-	-	-	-	0.11	0.30	0.41				
1.5 -1.65	-	-	-	-	0.04	0.22	2.67		-	-	-	-	0.03	0.08	0.11				
1.65 -1.8	-	-	-	-	-	0.01	0.09		-	-	-	-	0.02	-	-				
Loose		0.56	0.15	0.72	1.70	1.14	1.22			0.96	0.17	0.13	0.73	0.41	0.90				
TOTAL	6.34	5.52	14.02	32.10	52.09	59.64	75.60		3.24	4.67	10.62	20.83	35.88	56.00	65.86				

<sup>1</sup> June 13 sample not divided into depth increments.



**TABLE 16.—ROOT LENGTH PER UNIT GROUND SURFACE AREA (M/M<sup>3</sup>) FOR VARIOUS DEPTHS AND SAMPLING TIMES**  
[nonirrigated soybeans]

0.25 m rows (N25)										1 m rows (N100)										
Depth	Date and Days After Planting										Date and Days After Planting									
	June 13 [29]	June 21 [37]	June 28 [44]	July 09 [55]	July 26 [72]	Aug. 07 [84]	Aug. 20 [97]			June 13 [29]	June 21 [37]	June 28 [44]	July 13 [59]	July 26 [72]	Aug. 07 [84]	Aug. 20 [97]				
m	m/m <sup>2</sup>										m/m <sup>2</sup>									
0 -0.075		73	54	49	222	344	397				53	29	160	258	390	237				
0.075-0.15		106	367	198	379	337	575			128 <sup>1</sup>	115	186	125	381	296	225				
0.15 -0.225	211 <sup>1</sup>	50	181	283	217	130	274				23	72	72	129	221	117				
0.225-0.3		24	116	127	173	99	113				6	47	45	114	83	82				
0.3 -0.375	-	24	34	41	107	129	78			-	6	11	44	137	85	81				
0.375-0.45	-	10	31	49	112	92	98			-	10	11	53	137	99	82				
0.45 -0.525	-	2	24	66	115	107	123			-	2	16	58	130	124	105				
0.525-0.6	-	-	28	50	180	129	131			-	-	11	-	-	121	114				
0.6 -0.75	-	-	28	95	232	249	226			-	-	19	72	286	226	208				
0.75 -0.9	-	-	4	78	370	315	221			-	-	4	57	273	221	213				
0.9 -1.05	-	-	-	31	159	306	286			-	-	-	42	249	263	241				
1.05 -1.2	-	-	-	6	83	355	281			-	-	-	11	238	196	253				
1.2 -1.35	-	-	-	-	19	253	259			-	-	-	4	98	176	183				
1.35 -1.5	-	-	-	-	-	117	155			-	-	-	-	31	65	103				
1.5 -1.65	-	-	-	-	-	39	91			-	-	-	-	9	34	15				
1.65 -1.8	-	-	-	-	-	14	25			-	-	-	-	4	2	15				
Loose		35	21	37	22	86	138			-	9	3	40	75	72	190				
TOTAL	211	300	887	1111	2389	3100	3471			128	223	410	783	2550	2675	2464				

<sup>1</sup> June 13 sample not divided into depth increments.

TABLE 16.—ROOT LENGTH PER UNIT GROUND SURFACE AREA (M/M<sup>2</sup>) FOR VARIOUS DEPTHS AND SAMPLING TIMES—CONTINUED  
[irrigated soybeans]

0.25 m rows (125)										1.0 m rows (1100)									
Depth	Date and Days After Planting							Date and Days From Planting											
	June 13 [29]	June 21 [37]	June 27 [43]	July 12 [58]	July 25 [71]	Aug. 06 [83]	Aug. 20 [97]	June 13 [29]	June 21 [37]	June 27 [43]	July 12 [58]	July 25 [71]	Aug. 06 [83]	Aug. 20 [97]					
	m/m <sup>2</sup>							m/m <sup>2</sup>											
0 -0.075		22	30	51	226	499	332		77	30	70	252	394	470					
0.075-0.15		49	379	179	649	599	519		47	184	80	258	491	433					
0.15 -0.225	259 <sup>1</sup>	106	300	315	232	121	272	160 <sup>1</sup>	31	129	62	144	182	315					
0.225-0.3		36	146	97	50	71	140		6	36	30	98	60	160					
0.3 -0.375	-	11	35	32	54	43	106	-	5	18	25	71	39	72					
0.375-0.45	-	6	19	35	67	39	116	-	-	16	20	58	58	59					
0.45 -0.525	-	4	18	33	73	70	98	-	-	10	13	45	42	47					
0.525-0.6	-	-	16	35	72	106	109	-	-	6	12	56	39	49					
0.6 -0.75	-	-	22	8	104	154	148	-	-	16	27	80	63	98					
0.75 -0.9	-	-	4	13	103	175	154	-	-	4	26	87	78	100					
0.9 -1.05	-	-	-	7	125	118	134	-	-	-	19	56	138	122					
1.05 -1.2	-	-	-	-	137	117	132	-	-	-	9	31	202	130					
1.2 -1.35	-	-	-	-	78	93	133	-	-	-	2	30	125	93					
1.35 -1.5	-	-	-	-	57	63	110	-	-	-	-	13	46	55					
1.5 -1.65	-	-	-	-	4	41	78	-	-	-	-	3	8	12					
1.65 -1.8	-	-	-	-	-	-	7	-	-	-	-	2	-	-					
Loose	-	47	16	45	159	128	133	-	34	15	9	115	57	116					
TOTAL	259	280	984	850	2190	2437	2729	160	201	463	403	1397	2024	2332					

<sup>1</sup> June 13 sample not divided into depth increments.

**TABLE 17.—TOTAL ROOT LENGTH, ROOT LENGTH PER UNIT LEAF AREA, ROOT LENGTH PER UNIT ROOT MASS, AND SHOOT-ROOT RATIOS FOR IRRIGATED AND NONIRRIGATED SOYBEANS IN 0.25-M AND 1.0-M ROWS**

Days after planting	Date <sup>1</sup>	Total root length per unit soil surface				Root length/leaf area ratio			
		N25	N100	I25	I100	N25	N100	I25	I100
		mm				mm <sup>-2</sup>			
29	June 13	211	128	259	160	1055	640	1295	800
37	June 21	300	223	280	201	667	496	622	447
43	June 27	887	410	984	463	887	410	1036	514
58	July 12	1111	783	850	403	453	245	224	126
71	July 25	2389	2550	2190	1397	569	505	350	241
83	August 6	3100	2675	2437	2024	620	478	378	324
97	August 20	3471	2464	2729	2332	807	560	520	395
Mean		1638	1319	1390	997	723	476	632	407

Days after planting	Date <sup>1</sup>	Root length/root mass ratio				Shoot/root ratio			
		N25	N100	I25	I100	N25	N100	I25	I100
		mg <sup>-1</sup>							
29	June 13	57.1	44.0	40.9	49.4	2.8	5.9	2.1	4.1
37	June 21	41.7	43.8	50.7	43.0	3.9	5.0	6.0	7.1
43	June 27	44.8	58.5	70.2	43.6	4.0	6.6	4.3	5.6
58	July 12	23.1	36.8	26.5	19.3	4.9	5.7	6.9	9.8
71	July 25	38.2	39.7	42.0	38.9	5.3	6.1	8.2	11.7
83	August 6	39.2	37.1	40.9	36.1	5.7	8.7	9.9	10.6
97	August 20	36.9	35.1	36.1	35.4	6.1	9.9	9.7	13.8
Mean		40.1	42.1	43.9	38.0	4.7	6.8	6.7	3.9

<sup>1</sup>Root sampling was not completed on a single day. For actual sampling dates, see table 16.

The data points in these figures represent individual data points for each of the plots within the experimental area. To show the general trends, the data were smoothed using a 1-2-3-2-1 weighted running average for both the irrigated and nonirrigated treatments. Most of the scatter in the data could be directly attributed to the variations in solar radiation caused by intermittent clouds. Previous experience has indicated that the portable chamber was accurate to within  $\pm 0.05$  mm/hr and that differences larger than this can be considered real.

Diurnal changes in total leaf water potential and osmotic potential are presented for a number of days during the growth season (figs. 10 and 11). The first leaf water potential sampling (fig. 10) was on June 27, before the first irrigation, and no treatment effect could be detected. After we applied the first irrigation, the irrigated treatments had consistently greater total leaf water potentials than the nonirrigated treatments during the midday period. The difference was maintained even when heavy cloud cover occurred during the afternoon of August 8 (fig. 11). Osmotic potentials tended to vary little through the day but, as the season progressed, the irrigated treatments had generally higher (less negative) osmotic potentials. We could detect no effect of row spacing on total leaf water potential or osmotic potential under irrigated or nonirrigated conditions.

**TABLE 18.—APPARENT WATER UPTAKE FROM SOIL LAYERS SHOWN DURING LITTLE OR NO RAINFALL FOR THE NON-IRRIGATED 0.25-M ROWS (N25)**

Soil depth	Sampling period (days after planting)							
	42-48	48-51	51-58	58-63	77-80	80-85	85-91	91-97
m	-----Apparent water uptake (cm <sup>3</sup> /cm <sup>3</sup> /day x 10 <sup>-3</sup> )-----							
0- .15	6.54 <sup>1</sup>	2.60	2.80	-2.36	13.69	4.36	-0.33	1.62
.15- .30	6.08	3.98	4.44	0.04	0.30	3.12	0.45	0.50
.30- .61	0.52	7.37	4.46	3.00	0.43	2.46	0.37	-0.87
.61- .91	0.23	4.87	1.66	0.07	0.33	2.24	-0.28	0.25
.91-1.22	-0.78	4.00	0.53	1.62	1.50	2.62	-1.32	1.28
1.22-1.52	-1.05	3.03	0.27	-0.48	2.77	3.04	-3.80	3.18
1.52-1.83	-0.07	1.10	0.97	-1.36	2.07	2.80	-0.88	3.63
1.83-2.13	-0.47	0.57	1.64	-2.04	3.30	1.68	0.07	0.80
2.13-2.44	-1.75	2.90	1.50	-2.08	2.23	1.54	0.10	0.93
2.44-2.74	-0.42	1.93	1.04	-1.44	4.10	1.42	1.65	2.37
Total uncorrected uptake (mm)	4.5	26.1	33.3	6.2	21.4	32.3	7.3	22.8
Water uptake values corrected for flow between soil layers								
Soil depth	Sampling period (days after planting)							
	42-48	48-51	51-58	58-63	77-80	80-85	85-91	91-97
m	-----Corrected water uptake (cm <sup>3</sup> /cm <sup>3</sup> /day x 10 <sup>-3</sup> )-----							
0- .15	17.4 <sup>1</sup>	6.78	4.27	-2.01	11.90	4.27	0.33	1.62
.15- .30	-6.73	1.58	3.36	-0.35	2.05	3.20	-0.45	0.50
.30- .61	4.12	8.87	6.24	3.92	0.45	2.47	-0.37	-0.87
.61- .91	-2.06	3.69	1.57	8.36	0.45	2.29	0.30	0.26
.91-1.22	-1.94	2.59	-0.80	0.64	2.64	3.32	1.55	1.32
1.22-1.52	-0.61	2.83	-0.28	-2.22	3.40	3.72	4.77	3.90
1.52-1.83	-0.87	0.90	0.32	-2.10	1.11	2.14	0.82	4.54
1.83-2.13	0.91	1.44	1.95	-1.41	3.81	2.37	0.13	0.34
2.13-2.44	-2.29	1.46	1.91	-1.83	0.75	0.47	-0.92	0.31
2.44-2.74	-0.00	0.00	0.00	0.00	0.00	0.00	-0.00	0.00
Total corrected uptake (mm)	4.6	23.4	30.9	6.3	17.6	29.4	11.2	19.5

<sup>1</sup>Positive values indicate water uptake from the soil layer.

Some of the results presented here are discussed more fully in other reports (34, 35, 36).

**TABLE 19.—SUMMARY OF DAILY MEAN VALUES OF EVAPO-TRANSPIRATION, CASTANA, IOWA, 1979, AND RESULTS OF DUNCAN'S MULTIPLE RANGE TEST**

DATE	EVAPOTRANSPIRATION			
	25-cm SPACING		100-cm SPACING	
	IRRI-GATED	NONIR-RIGATED	IRRI-GATED	NONIR-RIGATED
	mm/hr			
JULY 10	0.496 a <sup>1</sup>	0.371 b	0.422 b	0.380 b
JULY 11	.384 a	.282 c	.336 b	.293 c
JULY 31	.289 b	.288 b	.309 a	.285 b
AUGUST 1	.469 a	.433 b,c	.458 a,b	.425 b
AUGUST 23 <sup>2</sup>	.420 a	.396 a,b	.420 a,b	.370 b

<sup>1</sup>MEANS FOLLOWED BY THE SAME LETTER WITHIN A GIVEN DAY INDICATE NO SIGNIFICANT DIFFERENCE USING THE DUNCAN'S MULTIPLE RANGE TEST AT THE 0.5 PROBABILITY LEVEL.

<sup>2</sup>DATA COLLECTION WAS POSSIBLE FOR ONLY A 2-3 HOUR PERIOD ON AUGUST 23 BECAUSE OF RAINFALL. DATA FROM THAT PERIOD ARE INCLUDED HERE BUT ARE NOT PRESENTED IN THE FOLLOWING FIGURES.

Text continues on page 43.

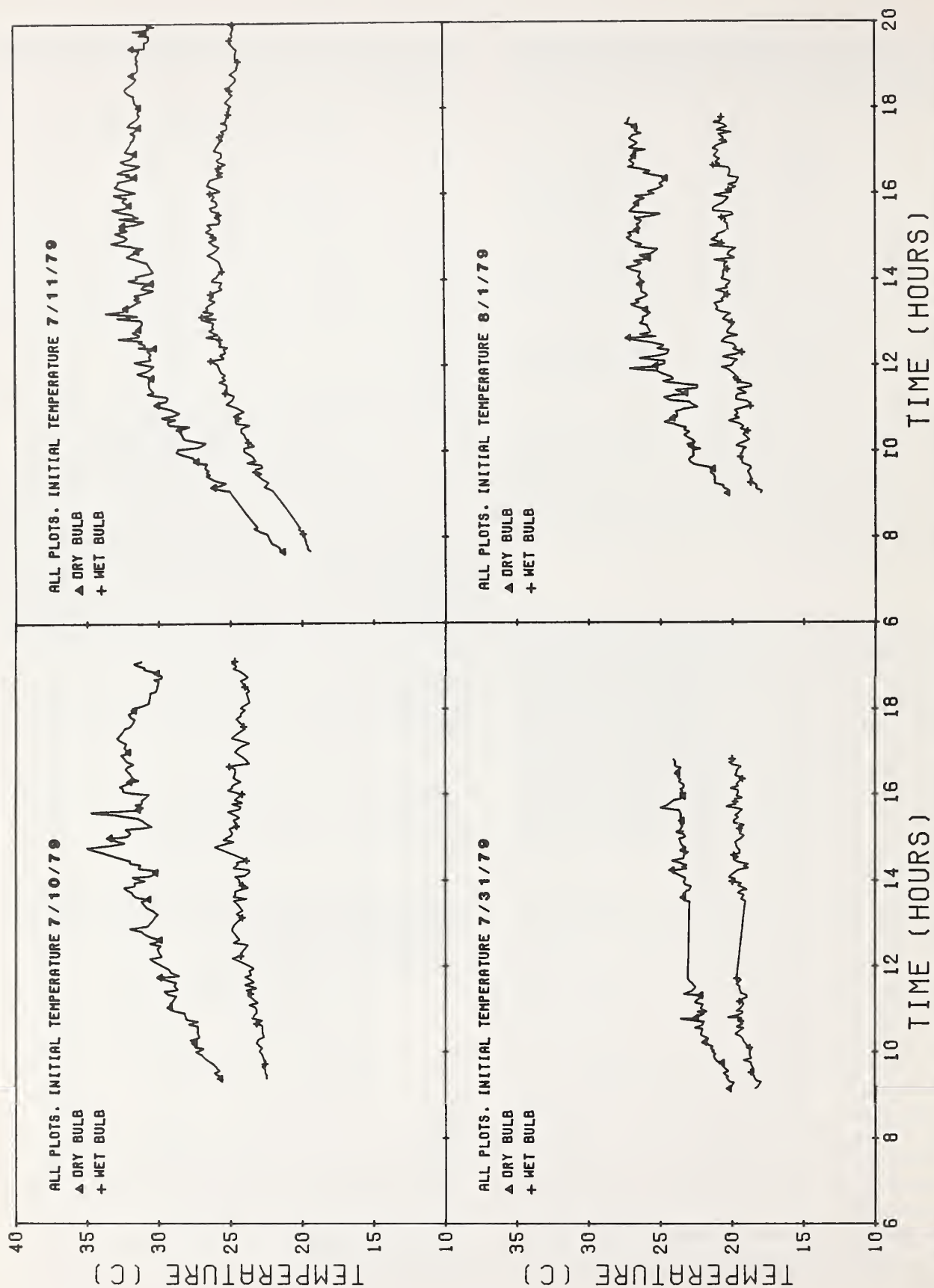


FIGURE 5.—Variations in wet- and dry-bulb temperatures with time (CDT) for July 10, 11, and 31 and August 1. The readings were taken in the evapotranspiration chamber before it was lowered onto the crop.



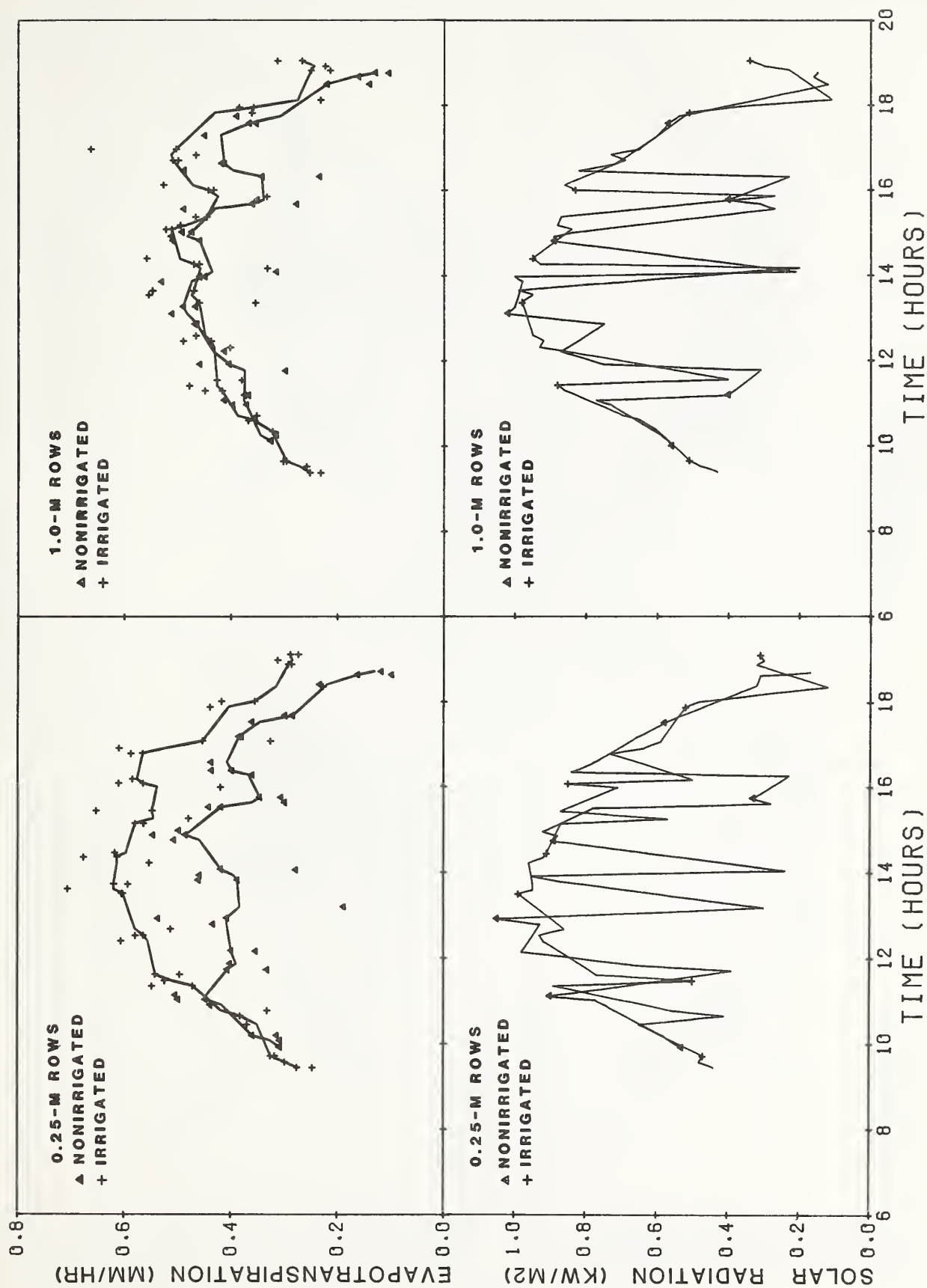


FIGURE 6.—Evapotranspiration and solar radiation versus time (CDT) for irrigated and nonirrigated soybeans in 0.25- and 1.0-m rows on July 10, 1979. Lines are weighted running averages (1-2-3-2-1).

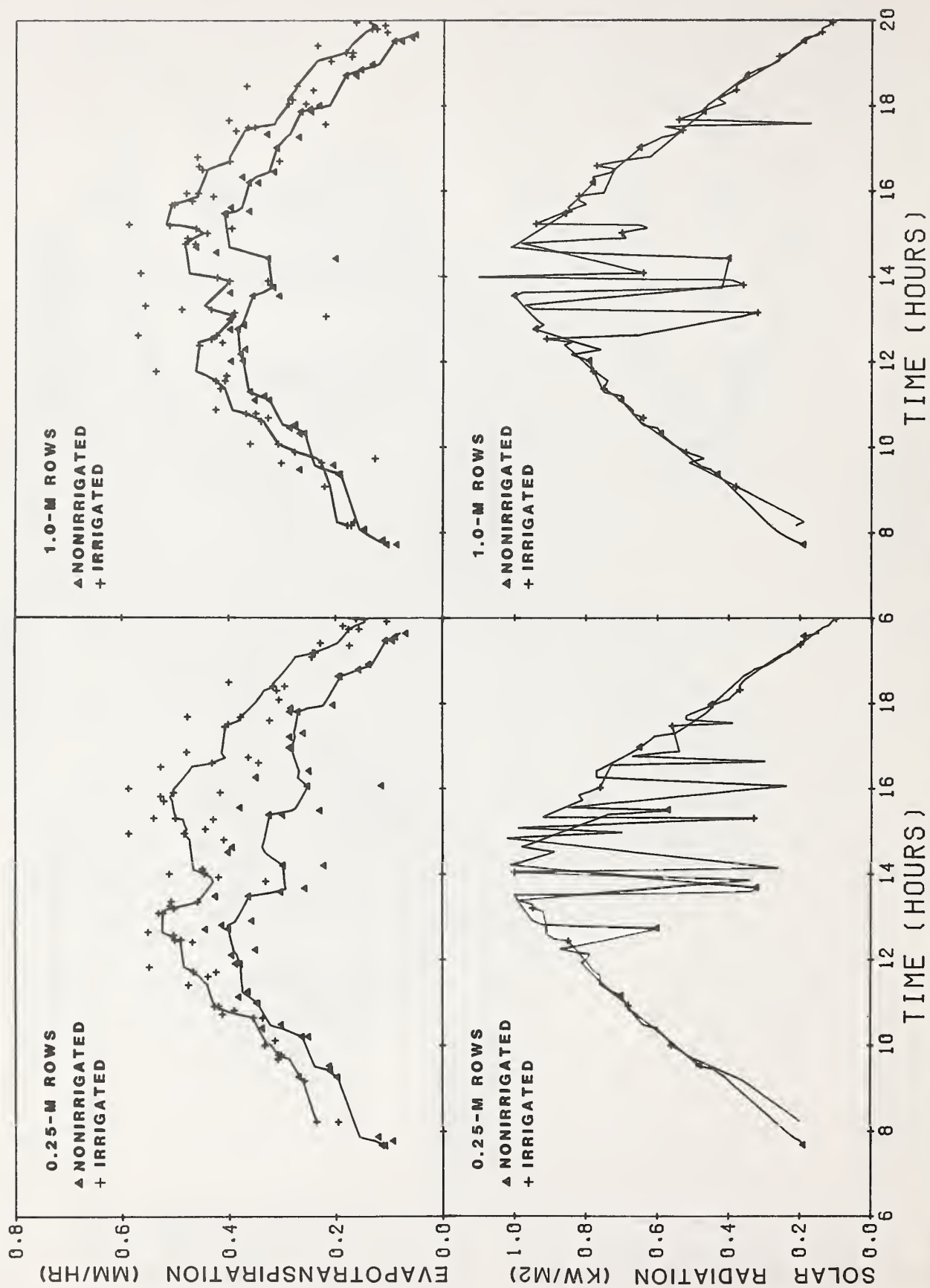


FIGURE 7.—Evapotranspiration and solar radiation versus time (CDT) for irrigated and nonirrigated soybeans in 0.25- and 1.0-m rows on July 11, 1979. Lines are weighted running averages (1-2-3-2-1).

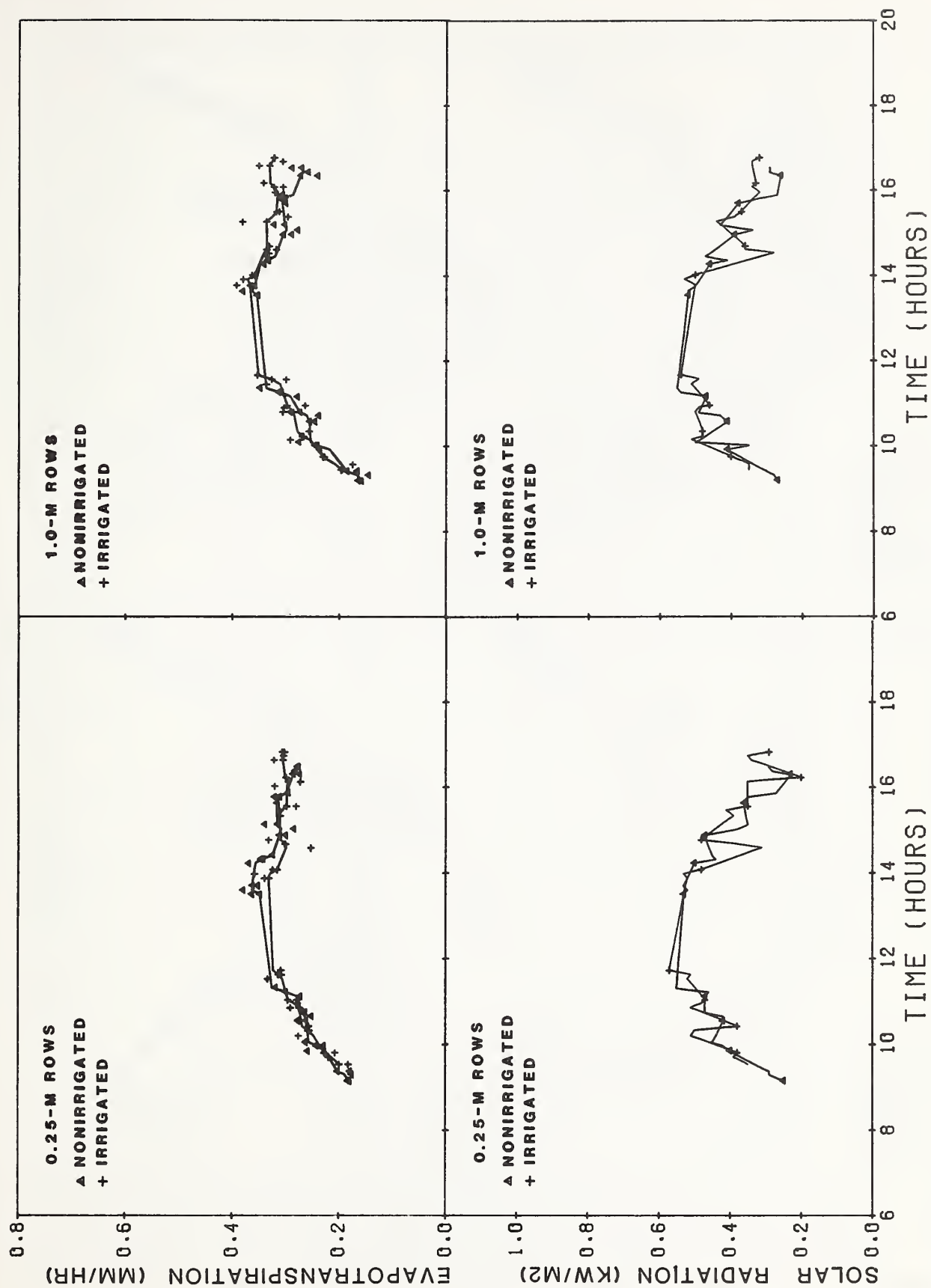


FIGURE 8.—Evapotranspiration and solar radiation versus time (CDT) for irrigated and nonirrigated soybeans in 0.25- and 1.0-m rows on July 31, 1979. Lines are weighted running averages (1-2-3-2-1).

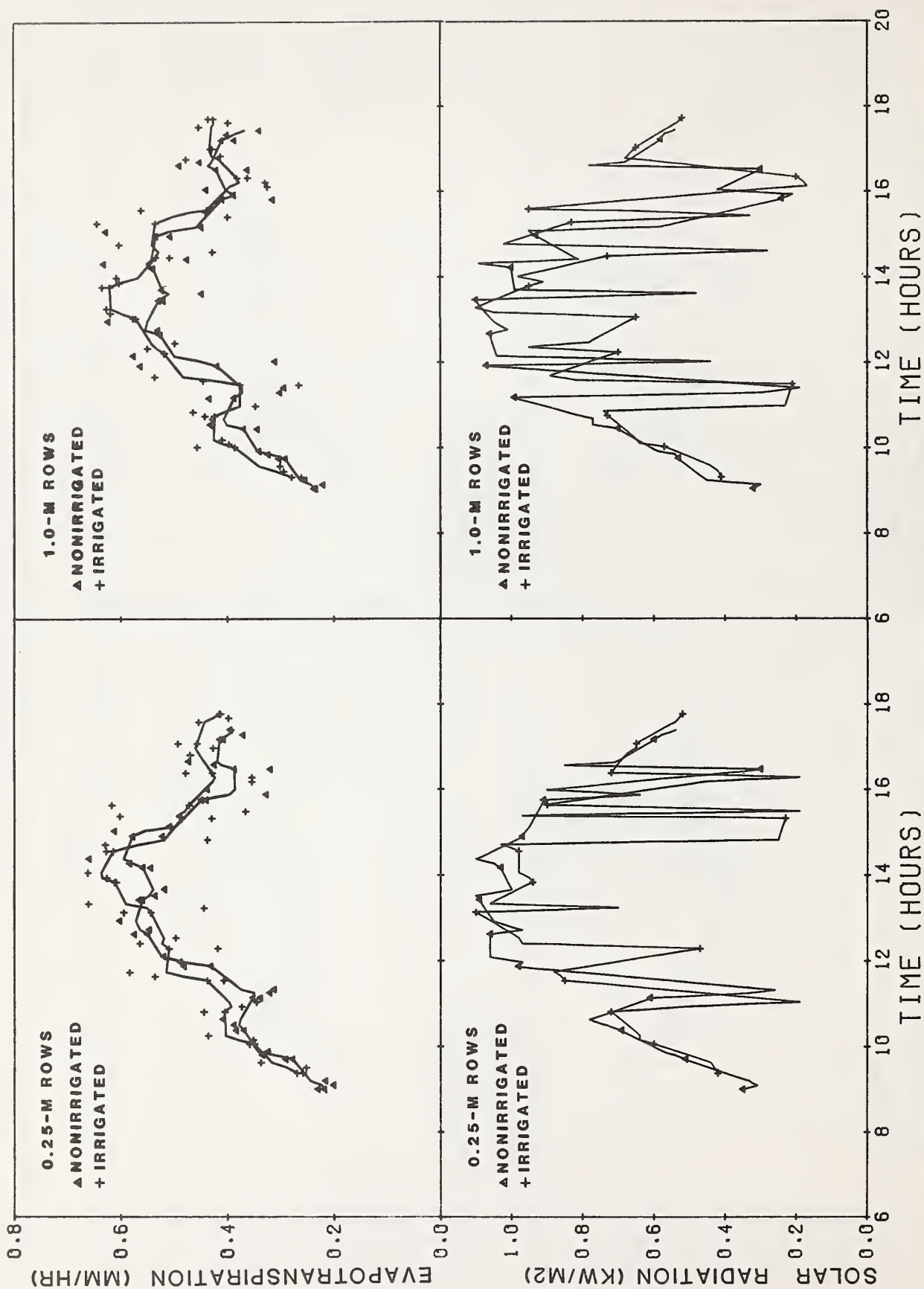


FIGURE 9.—Evapotranspiration and solar radiation versus time (CDT) for irrigated and nonirrigated soybeans in 0.25- and 1.0-m rows on August 1, 1979. Lines are weighted running averages (1-2-3-2-1).



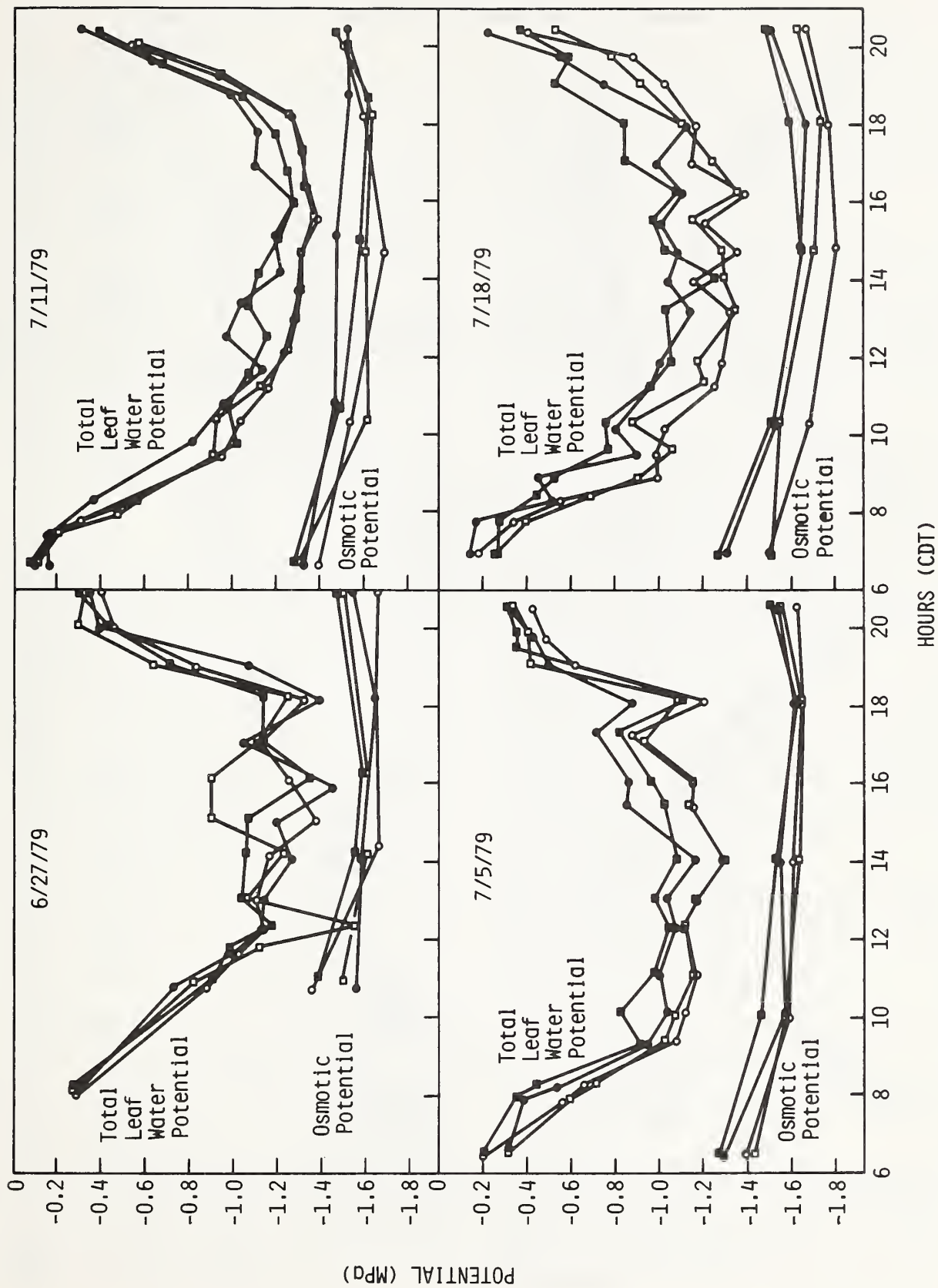


FIGURE 10.—Total leaf water potential and osmotic potential for 4 days from June 27 to July 18, 1979. Symbols are N25 (○), I25 (●), N100 (□), and I100 (■).

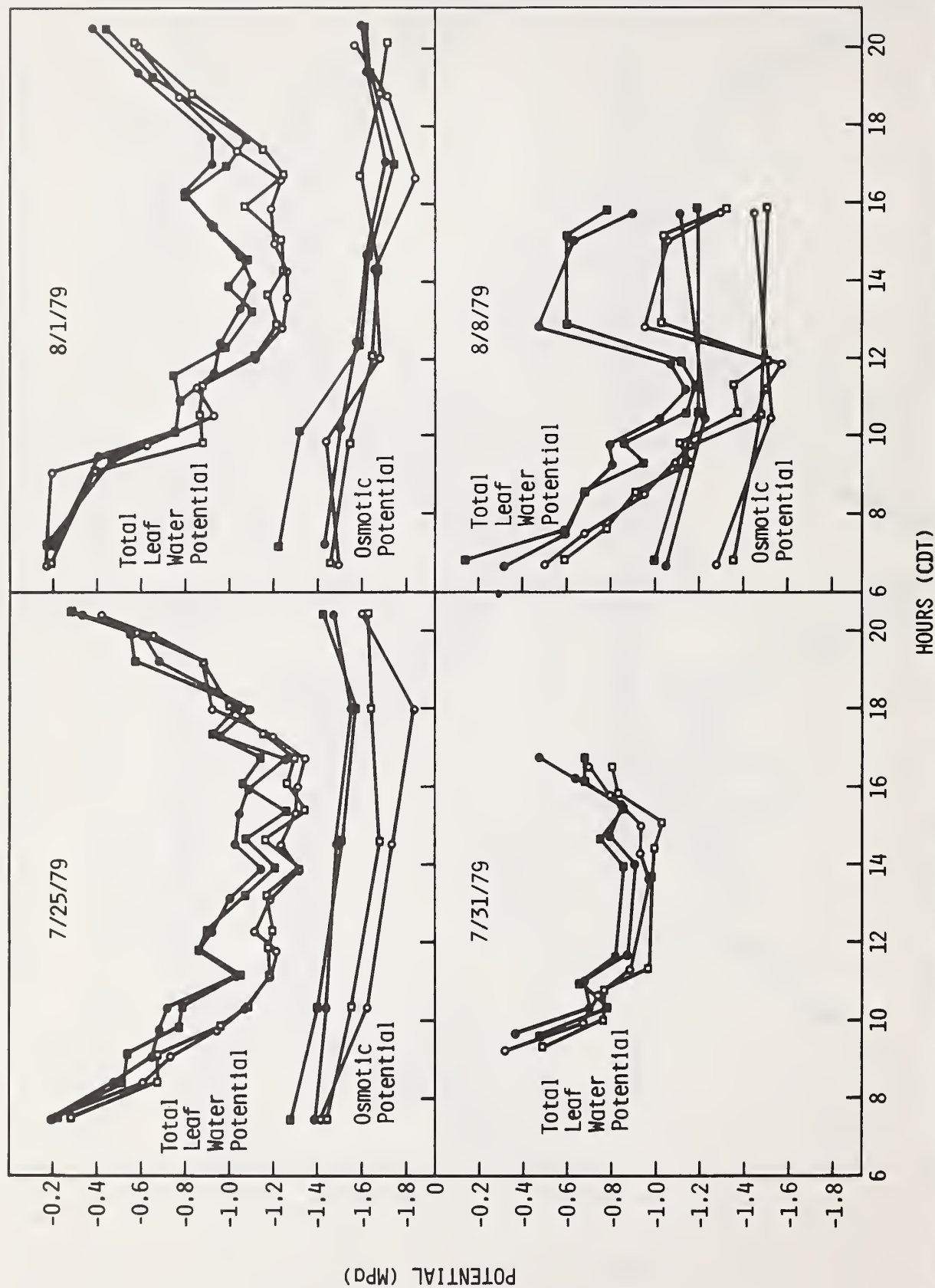


FIGURE 11.—Total leaf water potential and osmotic potential for 4 days from July 25 to August 8, 1979. No osmotic potentials were measured on July 31. Symbols are N25 (○), 125 (●), N100 (□), and 1100 (■).

## DATA SET IV. NUTRIENT UPTAKE AND ACCUMULATION

### Discussion

We conducted this section of the experimental program to obtain more complete information on the effects of row spacing and soil water level on soybean nutrition. As discussed previously, planting soybeans in narrow rows often results in increased seed yields when compared to wider-row spacings. In this experiment, a 17 percent yield increase resulted from planting soybeans in 0.25-m rows when compared to 1.0-m rows at equal plant populations.

Irrigation produced no effect on final seed yield. We hoped to determine whether these yield responses were caused by or related to the uptake or accumulation of mineral nutrients. The effects of the irrigation and row-spacing treatments on the uptake of the 12 elements sampled are discussed here. The following symbols are used extensively in the data tables: nonirrigated 0.25-m rows (N25), nonirrigated 1.0-m rows (N100), with I25 and I100 for the irrigated treatments.

**Nitrogen.**—The N concentrations of all plant components (table 20) were significantly greater in the irrigated plots than those in the nonirrigated plants, but the general trends over time were the same in all treatments. The N concentrations in leaves, stems plus petioles, and pod walls decreased with time. After an initial decrease until about day 70, the concentration in the total plant remained constant as N, remobilized from other plant parts, moved to the seeds.

Nodule weight was recorded in association with the root sampling on day 71, but no consistent effect of the treatments could be detected. An average dry mass of 5.5 g/m<sup>2</sup> of nodules was present in each treatment. Row spacing had little effect on N concentrations, even though the plants grown in 1.0-m rows were noticeably darker green during the early part of the season. Averaged over treatments, 46 percent (133.5 kg/ha) of the total N accumulated was removed by seed harvest.

**Phosphorus.**—As with N, P concentrations were strongly influenced by irrigation and tended to decrease in the vegetative material as the seeds filled (table 21). Only pod wall concentrations were significantly affected by row spacing (table 33), but the greater biomass production of the 1.0-m rows resulted in increased accumulation (on a total plant basis) for every element except Zn (table 30). On average, 38.8 percent (12.8 kg/ha) of the total P uptake was recovered at harvest in the seeds.

**Potassium.**—Irrigation significantly increased K

concentration in all plant components (table 22). Stems and pod walls had the highest K concentrations, unlike N and P where seed concentrations were the highest. Stem- and pod-wall concentrations were significantly increased by narrow-row spacing. At harvest, an average of 27.2 percent (41.4 kg/ha) of the total K uptake was recovered.

**Calcium.**—Among those analyzed, Ca was the only element where the tissue concentration was significantly decreased by irrigation (table 23). The lush growth of the irrigated soybeans possibly would have benefited if Ca concentrations had been higher because lodging was a problem in the irrigated plots. Ca is a very immobile element, and only 4.3 percent (7.5 kg/ha) of the total Ca uptake was recovered in seeds at harvest.

**Magnesium.**—Irrigation and row spacing had little effect on the concentration or accumulation of Mg (table 24). As with Ca, little Mg was transported to the seeds. On average, 10 percent (6.2 kg/ha) of the total Mg uptake was recovered at harvest.

**Sodium.**—Little can be concluded from the Na analysis as the concentration results were expressed as a percentage with two decimal places, and all were less than 0.05 percent (table 25). Some results were simply listed as < 0.01 percent.

**Manganese.**—Irrigation had no significant effects on Mn concentrations but, in general, wide-row spacing significantly increased Mn concentrations (table 26). Approximately 60 percent of all Mn accumulated was stored in the leaves. Total Mn uptake averaged only 0.56 kg/ha, and only 12.5 percent (0.07 kg/ha) was recovered at harvest.

**Iron.**—Irrigation significantly increased total plant Fe concentration, but there was no significant effect on any single plant component (table 27). Wide-row spacing also increased Fe concentrations. Of the total Fe uptake, 24.7 percent (0.29 kg/ha) was recovered at harvest.

**Boron.**—Concentration of B was significantly increased in all plant components by irrigation (table 28). B and Zn were unusual in that total plant concentrations were significantly increased by narrow-row spacing. Harvest recovery averaged 21.3 percent (0.09 kg/ha).

**Copper.**—Concentrations of Cu behaved in a similar way to the major nutrients N, P, and K (table 29). Irrigation caused significant concentration increases, and considerable translocation occurred from leaves, stems, and pod walls to the seeds. Consequently, har-



TABLE 20.—NITROGEN CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (%)										ACCUMULATION (KG/HA)														
DAY	NO	N25	TREATMENT				TREATMENT																	
			N100	125	1100	N25	N100	125	1100	N25	N100	125	1100											
SOYBEAN LEAVES																								
35	2	4.80	4.37	4.59	4.69	5.943	5.794	7.577	7.218	64	6	2.02	1.95	2.03	1.97	1.584	1.045	2.679	1.393					
42	3	4.83	5.06	4.33	4.80	13.259	12.374	11.729	13.552	71	7	1.56	1.65	1.63	1.81	2.300	2.197	5.265	2.911					
49	4	4.91	5.03	4.87	5.00	27.346	26.552	30.336	26.773	79	8	1.56	1.65	1.63	1.82	3.280	3.438	10.195	5.657					
56	5	4.67	4.84	4.64	4.83	36.407	36.454	39.783	42.747	86	9	1.56	1.65	1.63	1.82	4.754	4.853	14.353	8.526					
64	6	4.33	4.69	4.89	4.83	58.256	59.520	72.116	60.004	91	10	1.42	1.53	2.05	2.19	6.148	6.404	16.878	10.550					
71	7	4.16	4.27	4.68	4.69	58.560	76.960	89.044	103.724	99	11	1.42	1.53	2.05	2.19	8.669	19.930	12.988						
79	8	4.56	4.59	4.87	4.81	75.263	98.640	95.259	96.136	105	12	1.42	1.53	2.05	2.19	9.864	10.399	21.751	14.616					
86	9	4.25	4.35	5.00	4.96	82.371	102.006	103.474	106.595	113	13	1.42	1.53	2.05	2.19	11.643	12.822	25.055	19.056					
91	10	4.34	4.22	4.90	4.65	82.722	78.923	106.717	123.720	119	14	1.42	1.53	2.05	2.19	18.769	21.798	29.172	26.514					
99	11	3.80	3.81	4.64	4.41	59.271	66.851	82.513	102.596	128	15	----	----	----	----	----	----	44.239	44.305					
105	12	3.59	3.46	4.56	4.31	55.338	65.783	90.040	101.401	SOYBEAN PODWALLS														
111	13	2.87	2.99	3.87	3.61	46.711	50.785	80.023	92.390	71	7	3.40	3.23	4.04	3.86	0.121	0.575	0.108	0.413					
119	14	2.27	2.43	3.11	2.97	19.120	16.788	47.965	37.900	79	8	3.40	3.23	4.04	3.86	2.877	5.672	1.181	2.722					
128	15	----	----	2.77	2.60	----	----	20.501	4.829	86	9	3.40	3.23	4.04	3.86	20.474	27.683	17.044	19.237					
SOYBEAN BEANS															91	10	3.40	3.23	4.04	3.86	32.986	32.493	29.232	41.404
99	11	5.58	5.39	5.81	5.63	38.935	46.299	26.657	37.575	99	11	2.11	2.14	3.25	3.00	22.328	25.852	34.469	44.538					
105	12	5.58	5.39	5.81	5.63	72.779	66.379	60.148	76.733	105	12	2.11	2.14	3.25	3.00	23.593	24.676	45.280	49.990					
111	13	5.52	5.70	6.13	6.00	119.340	139.490	136.003	174.441	113	13	1.22	1.24	2.03	1.83	14.286	16.656	30.035	35.927					
119	14	5.52	5.70	6.13	6.00	146.502	173.328	182.979	188.929	119	14	1.22	1.24	2.03	1.83	13.133	15.883	19.836	27.060					
128	15	----	----	6.13	6.00	----	----	190.102	187.228	128	15	----	----	2.03	1.83	----	----	28.536	27.048					
SOYBEAN STEMS															TOTAL SOYBEAN PLANTS									
35	2	2.66	2.62	2.71	2.69	1.549	1.790	1.970	1.975	28	1	4.07	4.04	4.10	3.83	3.846	3.273	4.087	3.816					
42	3	2.76	2.67	2.59	2.59	3.788	3.420	3.469	3.728	35	2	4.12	3.76	4.01	4.08	7.492	7.584	9.548	9.193					
49	4	2.27	2.21	2.22	2.28	7.555	7.650	9.987	8.590	42	3	4.13	4.24	3.75	4.06	17.047	15.794	15.198	17.280					
56	5	1.86	2.04	1.94	2.09	11.513	12.032	15.027	16.006	49	4	3.92	3.92	3.76	3.88	34.901	34.202	40.323	35.363					
64	6	1.50	1.65	1.88	1.78	19.714	21.116	31.258	23.557	56	5	3.43	3.60	3.36	3.55	47.921	48.486	54.810	58.753					
71	7	1.46	1.41	1.81	1.61	22.135	30.007	45.346	41.865	64	6	2.92	3.15	3.25	3.23	79.555	81.681	106.053	84.954					
79	8	1.55	1.46	2.06	1.78	32.755	43.695	65.909	48.828	71	7	2.79	2.73	3.05	3.04	83.115	109.739	139.762	148.912					
86	9	1.61	1.62	2.07	1.97	46.630	56.673	81.202	71.483	79	8	2.93	2.82	3.14	3.09	114.175	151.445	172.543	153.343					
91	10	1.68	1.53	2.17	2.08	49.698	45.952	91.167	98.445	86	9	2.79	2.80	3.24	3.21	154.229	191.215	216.074	205.841					
99	11	1.50	1.55	1.96	2.03	38.932	47.137	73.533	102.107	91	10	2.90	2.74	3.38	3.20	171.554	163.772	243.994	274.119					
105	12	1.17	1.27	2.09	1.88	35.043	40.598	92.453	88.098	99	11	2.76	2.79	3.29	3.12	168.023	194.809	237.101	299.798					
111	13	0.98	1.00	1.69	1.53	29.155	33.571	80.121	77.634	105	12	2.81	2.75	3.47	3.26	196.618	207.836	309.672	330.837					
119	14	0.75	0.78	1.39	1.23	19.324	21.719	59.444	48.114	113	13	2.77	2.84	3.29	3.14	221.136	253.325	351.237	399.450					
128	15	----	----	1.37	1.39	----	----	48.784	42.014	119	14	2.86	3.00	3.40	3.26	216.848	249.516	339.396	328.517					
										128	15	----	----	3.47	3.55	----	----	332.164	305.424					



TABLE 21.—PHOSPHORUS CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (%)										ACCUMULATION (KG/HA)					ACCUMULATION (KG/HA)				
TREATMENT										TREATMENT					TREATMENT				
DAY	NO	N25	N100	I25	I100	N25	N100	I25	I100	N25	N100	I25	I100	N25	N100	I25	I100		
SOYBEAN LEAVES																			
35	2	0.39	0.42	0.35	0.36	0.483	0.556	0.598	0.551										
42	3	0.45	0.43	0.39	0.42	1.231	1.056	1.064	1.162										
49	4	0.45	0.44	0.42	0.44	2.518	2.307	2.622	2.330										
56	5	0.37	0.41	0.46	0.42	2.915	3.122	3.904	3.696										
64	6	0.35	0.37	0.44	0.42	4.682	4.738	6.497	5.257										
71	7	0.32	0.34	0.41	0.42	4.521	6.222	7.866	9.353										
79	8	0.33	0.34	0.44	0.44	5.436	7.431	8.559	8.690										
86	9	0.29	0.31	0.39	0.38	5.532	7.266	8.010	8.146										
91	10	0.30	0.28	0.39	0.40	5.787	5.294	8.485	10.576										
99	11	0.28	0.30	0.44	0.45	4.481	5.193	7.801	10.390										
105	12	0.27	0.24	0.38	0.37	4.204	4.544	7.408	8.770										
111	13	0.25	0.25	0.32	0.33	4.157	4.297	6.661	8.449										
119	14	0.25	0.24	0.31	0.29	2.058	1.662	4.831	3.623										
128	15	----	----	0.29	0.26	----	----	2.190	0.499										
SOYBEAN SHED COMPONENTS																			
64	6	0.26	0.25	0.19	0.23	0.198	0.134	0.253	0.168										
71	7	0.14	0.18	0.14	0.16	0.265	0.255	0.478	0.302										
79	8	0.14	0.18	0.14	0.16	0.356	0.390	0.900	0.544										
86	9	0.14	0.18	0.14	0.16	0.490	0.546	1.248	0.794										
91	10	0.12	0.14	0.26	0.27	0.608	0.692	1.562	1.043										
99	11	0.12	0.14	0.26	0.27	0.810	0.901	1.942	1.335										
105	12	0.12	0.14	0.26	0.27	0.919	1.059	2.170	1.536										
111	13	0.12	0.14	0.26	0.27	1.071	1.288	2.592	2.078										
119	14	0.12	0.14	0.26	0.27	1.671	2.124	3.111	3.014										
128	15	----	----	0.26	0.27	----	----	5.001	5.230										
SOYBEAN PODWALLS																			
71	7	0.44	0.41	0.57	0.54	0.016	0.073	0.015	0.057										
79	8	0.44	0.41	0.57	0.54	0.379	0.719	0.169	0.379										
86	9	0.44	0.41	0.57	0.54	2.651	3.522	2.405	2.671										
91	10	0.44	0.41	0.57	0.54	4.358	4.126	4.138	5.759										
99	11	0.24	0.27	0.47	0.43	2.569	3.234	5.002	6.376										
105	12	0.24	0.27	0.47	0.43	2.726	3.083	6.539	7.148										
113	13	0.18	0.17	0.33	0.28	2.104	2.332	4.922	5.585										
119	14	0.18	0.17	0.33	0.28	1.936	2.237	3.244	4.192										
128	15	----	----	0.33	0.28	----	----	4.660	4.190										

TABLE 22.—POTASSIUM CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (%)												ACCUMULATION (KG/HA)				
DAY	NO	N25	TREATMENT				TREATMENT				TREATMENT					
			N100	125	1100	1100	N25	N100	125	1100	N25	N100	125	1100		
SOYBEAN LEAVES																
35	2	1.68	1.72	1.70	1.64	2.074	2.282	2.840	2.472							
42	3	1.89	1.76	1.62	1.69	5.191	4.340	4.524	4.759							
49	4	1.84	1.95	1.76	1.81	10.252	10.357	10.931	9.542							
56	5	1.47	1.66	1.75	1.68	11.449	12.526	14.959	14.803							
64	6	1.53	1.55	1.71	1.67	20.538	19.600	25.236	20.874							
71	7	1.41	1.44	1.78	1.77	20.040	26.068	33.711	39.210							
79	8	1.46	1.50	1.88	1.88	24.065	32.285	36.890	37.682							
86	9	1.62	1.68	1.95	1.83	31.158	39.729	40.467	39.412							
91	10	1.58	1.69	1.94	1.86	29.845	31.413	42.148	49.549							
99	11	1.47	1.55	1.95	1.92	22.865	26.697	34.865	44.782							
105	12	1.10	1.00	1.55	1.47	16.785	18.933	30.477	34.466							
113	13	0.94	0.91	1.32	1.21	15.356	15.524	27.151	31.049							
119	14	0.92	0.79	1.29	1.19	7.757	5.396	19.729	15.460							
128	15	----	----	1.24	1.21	----	----	9.240	2.143							
SOYBEAN SHED COMPONENTS																
64	6	0.27	0.28	0.32	0.22	0.221	0.152	0.421	0.164							
71	7	0.26	0.18	0.34	0.27	0.339	0.273	0.962	0.390							
79	8	0.26	0.18	0.34	0.27	0.502	0.405	1.987	0.793							
86	9	0.26	0.18	0.34	0.27	0.750	0.558	2.849	1.215							
91	10	0.44	0.56	1.10	0.88	1.181	1.137	4.203	2.027							
99	11	0.44	0.56	1.10	0.88	1.945	1.967	5.835	3.002							
105	12	0.44	0.56	1.10	0.88	2.377	2.596	6.808	3.657							
113	13	0.44	0.56	1.10	0.88	2.881	3.508	8.581	5.417							
119	14	0.44	0.56	1.10	0.88	5.100	6.843	10.784	8.398							
128	15	----	----	1.10	0.88	----	----	18.861	15.503							
SOYBEAN PODWALLS																
71	7	2.75	2.61	3.07	2.91	0.098	0.468	0.082	0.310							
79	8	2.75	2.61	3.07	2.91	2.343	4.579	0.910	2.058							
86	9	2.75	2.61	3.07	2.91	16.504	22.458	12.940	14.454							
91	10	2.75	2.61	3.07	2.91	26.908	26.298	22.268	31.220							
99	11	1.93	2.01	2.44	2.27	19.938	24.269	25.979	33.769							
105	12	1.93	2.01	2.44	2.27	21.266	23.286	33.822	37.966							
113	13	2.11	1.99	2.33	2.14	24.255	26.401	34.698	42.009							
119	14	2.11	1.99	2.33	2.14	22.450	25.692	23.211	31.633							
128	15	----	----	2.33	2.14	----	----	32.751	31.586							

CONCENTRATION (%)												ACCUMULATION (KG/HA)				
DAY	NO	N25	TREATMENT				TREATMENT				TREATMENT					
			N100	125	1100	1100	N25	N100	125	1100	N25	N100	125	1100		
SOYBEAN STEMS																
35	2	2.55	2.57	2.51	2.39	1.494	1.749	1.834	1.785							
42	3	2.96	2.60	2.54	2.86	4.061	3.304	3.451	4.020							
49	4	2.66	2.74	2.73	2.73	8.904	9.442	12.301	10.221							
56	5	2.35	2.64	2.60	2.66	14.475	15.618	20.069	20.427							
64	6	2.26	2.28	3.09	2.79	29.796	29.170	51.440	36.896							
71	7	1.82	1.85	3.00	2.99	27.745	39.344	75.929	77.560							
79	8	2.05	1.98	3.11	2.68	43.215	58.785	99.242	71.988							
86	9	1.87	2.03	2.61	2.54	54.121	72.887	102.481	91.949							
91	10	1.65	2.00	2.48	2.18	48.363	59.600	104.034	103.266							
99	11	1.53	1.62	2.42	2.19	38.630	48.060	90.934	110.682							
105	12	1.16	1.23	2.04	1.54	33.986	39.347	89.375	72.007							
113	13	1.06	1.17	1.61	1.32	31.224	38.707	76.360	67.659							
119	14	1.07	1.05	1.32	1.29	27.465	28.570	55.861	50.324							
128	15	----	----	1.48	1.30	----	----	52.400	39.700							
SOYBEAN BEANS																
99	11	1.94	1.95	2.26	2.17	13.630	17.025	10.318	14.610							
105	12	1.94	1.95	2.26	2.17	25.520	24.197	23.497	30.092							
113	13	1.98	1.95	1.88	1.95	42.818	47.633	41.787	56.843							
119	14	1.98	1.95	1.88	1.95	52.424	59.429	56.122	61.646							
128	15	----	----	1.88	1.95	----	----	58.376	61.017							
TOTAL SOYBEAN PLANTS																
28	1	2.03	1.99	1.97	1.84	1.920	1.610	1.970	1.832							
35	2	1.96	2.00	1.96	1.89	3.567	4.031	4.673	4.257							
42	3	2.24	2.05	1.97	2.06	9.252	7.644	7.975	8.779							
49	4	2.15	2.27	2.16	2.17	19.156	19.799	23.232	19.763							
56	5	1.85	2.09	2.14	2.13	25.924	28.144	35.028	35.230							
64	6	1.86	1.89	2.36	2.20	50.556	48.923	77.097	57.935							
71	7	1.62	1.65	2.41	2.40	48.222	66.153	110.683	117.471							
79	8	1.80	1.79	2.53	2.27	70.125	96.055	139.029	112.522							
86	9	1.85	1.98	2.38	2.29	102.534	135.631	158.737	147.029							
91	10	1.80	1.98	2.39	2.17	106.297	118.447	172.653	186.062							
99	11	1.59	1.69	2.33	2.15	97.008	118.016	167.932	206.845							
105	12	1.43	1.43	2.06	1.75	99.933	108.359	183.979	178.187							
113	13	1.46	1.48	1.77	1.60	116.532	131.773	188.577	202.977							
119	14	1.52	1.51	1.66	1.66	115.196	125.929	165.708	167.462							
128	15	----	----	1.80	1.74	----	----	171.629	149.950							

TABLE 23.—CALCIUM CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (%)										ACCUMULATION (KG/HA)									
TREATMENT					TREATMENT					TREATMENT					TREATMENT				
DAY	N0	N25	N100	N25	N100	N25	N100	N25	N100	DAY	N0	N25	N100	N25	N100	N25	N100	N25	N100
SOYBEAN LEAVES																			
35	2	2.41	2.46	2.29	2.33	2.959	3.276	3.825	3.469	35	2	1.92	2.18	1.72	1.88	1.104	1.483	1.206	1.373
42	3	2.47	2.49	2.27	2.41	6.805	6.075	6.131	6.775	42	3	1.98	1.92	1.80	2.12	2.709	2.457	2.348	3.063
49	4	2.29	2.29	2.17	2.17	12.714	12.065	13.529	11.632	49	4	1.91	1.82	1.82	1.71	6.374	6.222	8.253	6.433
56	5	2.29	2.31	2.30	2.22	17.856	17.512	19.742	19.637	56	5	1.80	1.77	1.64	1.67	11.147	10.489	12.680	12.806
64	6	2.35	2.29	2.04	2.01	31.271	29.055	30.137	24.990	64	6	1.94	1.79	1.69	1.78	25.180	22.796	28.038	23.518
71	7	2.16	2.06	1.56	1.85	30.398	37.198	29.644	41.007	71	7	1.44	1.18	1.18	1.17	21.959	25.163	29.770	30.385
79	8	2.37	2.42	1.64	1.84	39.019	52.113	32.204	36.589	79	8	1.51	1.32	1.17	1.20	31.843	39.330	37.595	32.403
86	9	2.76	2.89	2.07	2.38	53.520	67.864	42.962	50.870	86	9	1.79	1.72	1.43	1.62	51.865	60.938	55.915	58.463
91	10	3.02	2.81	2.28	2.53	57.699	52.716	49.604	67.549	91	10	1.86	1.89	1.63	1.71	54.284	56.701	68.414	80.110
99	11	3.05	3.28	2.51	2.82	47.979	57.602	45.154	65.646	99	11	1.59	1.74	1.52	1.49	40.118	52.398	57.518	74.892
105	12	2.78	2.69	2.28	2.76	42.857	50.722	45.047	65.061	105	12	1.48	1.37	1.31	1.34	42.884	43.451	57.512	62.645
113	13	3.15	3.15	2.77	3.13	51.653	52.981	56.728	80.211	113	13	1.48	1.53	1.31	1.42	43.234	50.110	61.769	72.429
119	14	3.31	3.48	3.31	3.34	27.148	23.323	51.259	42.075	119	14	1.43	1.36	1.41	1.54	36.381	37.206	60.496	59.223
128	15	----	----	3.31	3.67	-----	-----	24.436	7.173	128	15	----	----	1.55	1.26	-----	-----	55.169	38.289
SOYBEAN SHED COMPONENTS																			
64	6	5.19	5.63	4.82	5.01	4.086	2.998	6.273	3.540	99	11	0.42	0.46	0.47	0.50	2.931	3.984	2.171	3.276
71	7	4.65	5.04	3.80	4.22	6.225	6.262	12.292	7.025	105	12	0.42	0.46	0.47	0.50	5.504	5.741	4.811	6.723
79	8	4.65	5.04	3.80	4.22	9.154	10.036	23.774	13.332	113	13	0.35	0.38	0.36	0.40	7.638	9.353	7.979	11.691
86	9	4.65	5.04	3.80	4.22	13.579	14.429	33.508	19.865	119	14	0.35	0.38	0.36	0.40	9.363	11.650	10.690	12.572
91	10	3.71	3.62	2.94	3.25	17.216	18.131	37.138	22.884	128	15	----	----	0.36	0.40	-----	-----	11.140	12.497
99	11	3.71	3.62	2.94	3.25	23.510	23.501	41.478	26.496	TOTAL SOYBEAN PLANTS									
105	12	3.71	3.62	2.94	3.25	26.935	27.597	44.054	28.918	28	1	2.22	2.26	2.03	1.94	2.094	1.829	2.021	1.935
113	13	3.71	3.62	2.94	3.25	31.553	33.419	48.730	35.419	35	2	2.23	2.36	2.12	2.15	4.063	4.759	5.031	4.842
119	14	3.71	3.62	2.94	3.25	50.149	54.900	54.552	46.486	42	3	2.30	2.29	2.09	2.31	9.514	8.533	8.479	9.838
128	15	----	----	2.94	3.25	-----	-----	76.051	72.822	49	4	2.15	2.10	2.03	1.98	19.087	18.288	21.782	18.065
SOYBEAN PODWALLS																			
71	7	1.35	1.27	1.35	1.31	0.048	0.227	0.036	0.140	56	5	2.07	2.08	1.99	1.96	29.003	28.000	32.421	32.443
79	8	1.35	1.27	1.35	1.31	1.147	2.223	0.402	0.919	64	6	2.22	2.12	1.97	1.98	60.536	54.849	64.448	52.048
86	9	1.35	1.27	1.35	1.31	8.070	10.904	5.712	6.567	71	7	1.97	1.72	1.56	1.60	58.630	68.850	71.741	78.557
91	10	1.35	1.27	1.35	1.31	13.172	12.762	9.846	14.011	79	8	2.08	1.93	1.71	1.68	81.164	103.701	93.975	83.247
99	11	0.97	1.01	0.93	0.94	10.044	12.359	10.034	13.964	86	9	2.30	2.25	2.07	2.12	127.033	154.136	138.098	135.765
105	12	0.97	1.01	0.93	0.94	10.712	11.770	12.850	15.627	91	10	2.41	2.35	2.28	2.16	142.371	140.311	165.002	184.554
113	13	1.10	1.06	0.85	0.84	12.650	14.042	12.647	16.446	99	11	2.05	2.15	2.17	1.92	124.583	149.845	156.355	184.275
119	14	1.11	1.06	0.85	0.84	11.726	13.740	8.484	12.373	105	12	1.84	1.84	1.84	1.76	128.892	139.282	164.273	178.974
128	15	----	----	0.85	0.84	-----	-----	11.897	12.334	113	13	1.84	1.79	1.76	1.70	146.728	159.904	187.853	216.196
										119	14	1.77	1.69	1.86	1.72	134.767	140.820	185.482	172.728
										128	15	----	----	1.87	1.66	-----	-----	178.694	143.116



TABLE 24.—MAGNESIUM CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (%)										ACCUMULATION (KG/HA)									
TREATMENT					TREATMENT					TREATMENT					TREATMENT				
DAY	N0	N25	N100	N125	DAY	N0	N25	N100	N125	DAY	N0	N25	N100	N125	DAY	N0	N25	N100	N125
SOYBEAN LEAVES																			
35	2	0.99	0.87	1.11	1.01	1.124	1.162	1.868	1.533	35	2	0.65	0.71	0.72	0.79	0.378	0.487	0.511	0.574
42	3	0.89	0.90	1.03	1.01	2.464	2.209	2.737	2.840	42	3	0.62	0.77	0.76	0.74	0.839	0.987	0.977	1.095
49	4	0.76	0.73	0.84	0.81	4.200	3.860	5.270	4.378	49	4	0.58	0.54	0.68	0.59	1.922	1.852	3.123	2.236
56	5	0.76	0.75	0.84	0.80	5.932	5.714	7.202	7.139	56	5	0.65	0.62	0.66	0.65	4.046	3.666	5.106	5.016
64	6	0.73	0.73	0.70	0.70	9.755	9.283	10.269	8.647	64	6	0.70	0.66	0.69	0.70	9.187	8.447	11.382	9.275
71	7	0.69	0.68	0.56	0.54	9.741	12.455	10.568	14.085	71	7	0.60	0.57	0.56	0.58	9.106	12.200	14.080	15.102
79	8	0.65	0.70	0.51	0.59	10.685	15.386	9.982	11.743	79	8	0.62	0.62	0.57	0.59	13.132	18.659	18.398	16.041
86	9	0.60	0.66	0.47	0.58	11.653	15.181	9.677	12.400	86	9	0.57	0.56	0.54	0.63	16.462	19.727	21.097	22.314
91	10	0.72	0.56	0.51	0.59	13.981	10.450	11.064	15.734	91	10	0.65	0.55	0.61	0.63	19.367	16.629	25.464	29.417
99	11	0.68	0.75	0.51	0.62	11.080	13.415	9.171	14.310	99	11	0.67	0.76	0.66	0.66	17.392	23.038	25.102	32.951
105	12	0.58	0.58	0.44	0.55	9.154	10.999	8.714	13.005	105	12	0.62	0.62	0.60	0.61	18.375	19.507	26.280	28.456
113	13	0.64	0.65	0.44	0.56	10.690	11.016	9.037	14.256	113	13	0.66	0.72	0.63	0.69	19.530	23.726	29.634	35.037
119	14	0.65	0.74	0.48	0.53	5.354	4.965	7.364	6.549	119	14	0.66	0.72	0.69	0.74	17.030	19.914	29.338	28.278
128	15	-----	-----	0.51	0.59	-----	-----	3.745	1.178	128	15	-----	-----	0.83	0.71	-----	-----	29.506	21.496
SOYBEAN SHED COMPONENTS																			
64	6	1.12	1.22	1.17	1.11	0.858	0.650	1.533	0.800	99	11	0.27	0.29	0.30	0.29	1.895	2.464	1.343	1.941
71	7	1.12	1.20	1.04	1.12	1.390	1.401	3.182	1.722	105	12	0.28	0.29	0.30	0.29	3.564	3.585	3.088	3.996
79	8	1.12	1.20	1.04	1.12	2.105	2.296	6.331	3.407	113	13	0.27	0.29	0.28	0.30	6.051	7.077	6.135	8.608
86	9	1.12	1.20	1.04	1.12	3.167	3.348	8.967	5.157	119	14	0.28	0.29	0.28	0.30	7.411	8.821	8.235	9.348
91	10	0.81	0.88	0.77	0.82	3.960	4.257	9.918	5.912	128	15	-----	-----	0.28	0.30	-----	-----	8.571	9.267
99	11	0.81	0.88	0.77	0.82	5.314	5.574	11.068	6.810	TOTAL SOYBEAN PLANTS									
105	12	0.81	0.88	0.77	0.82	6.033	6.572	11.753	7.409	28	1	0.83	0.74	0.91	0.80	0.780	0.597	0.912	0.801
113	13	0.81	0.88	0.77	0.82	7.085	7.991	12.976	9.065	35	2	0.83	0.82	1.00	0.94	1.501	1.649	2.379	2.107
119	14	0.81	0.88	0.77	0.82	11.129	13.208	14.516	11.856	42	3	0.80	0.86	0.92	0.92	3.304	3.196	3.713	3.935
128	15	-----	-----	0.77	0.82	-----	-----	20.168	18.488	49	4	0.69	0.65	0.78	0.73	6.122	5.712	8.393	6.614
SOYBEAN PODWALLS																			
71	7	0.58	0.54	0.54	0.53	0.021	0.096	0.015	0.057	56	5	0.71	0.70	0.75	0.73	9.978	9.380	12.308	12.155
79	8	0.58	0.54	0.54	0.53	0.493	0.947	0.160	0.376	64	6	0.73	0.71	0.71	0.71	19.800	18.380	23.184	18.721
86	9	0.58	0.54	0.54	0.53	3.443	4.635	2.286	2.654	71	7	0.68	0.65	0.61	0.63	20.258	26.154	27.845	30.967
91	10	0.58	0.54	0.54	0.53	5.677	5.434	3.925	5.719	79	8	0.68	0.69	0.64	0.64	26.416	37.289	34.871	31.567
99	11	0.56	0.57	0.48	0.49	5.874	6.981	5.128	7.322	86	9	0.63	0.63	0.63	0.66	34.726	42.891	42.027	42.525
105	12	0.56	0.57	0.48	0.49	6.248	6.650	6.654	8.235	91	10	0.73	0.61	0.70	0.66	42.986	36.770	50.372	56.783
113	13	0.72	0.66	0.46	0.47	8.304	8.776	6.796	9.094	99	11	0.68	0.74	0.72	0.66	41.555	51.472	51.813	63.333
119	14	0.72	0.66	0.46	0.47	7.688	8.608	4.557	6.879	105	12	0.62	0.63	0.63	0.60	43.375	47.272	56.489	61.100
128	15	-----	-----	0.46	0.47	-----	-----	6.403	6.853	113	13	0.65	0.66	0.61	0.60	51.660	58.586	64.579	76.060
										119	14	0.64	0.67	0.64	0.62	48.612	55.517	64.009	62.910
										128	15	-----	-----	0.72	0.67	-----	-----	68.393	57.282



TABLE 25.—SODIUM CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (%)										ACCUMULATION (KG/HA)													
TREATMENT					TREATMENT					TREATMENT					TREATMENT								
DAY	N0	N25	N100	N125	N1100	DAY	N0	N25	N100	N125	N1100	DAY	N0	N25	N100	N125	N1100	DAY	N0	N25	N100	N125	N1100
SOYBEAN LEAVES																							
35	2	0.03	0.02	0.02	0.03	0.037	0.031	0.037	0.040	0.040	0.040	35	2	0.03	0.03	0.03	0.03	0.019	0.020	0.022	0.022	0.022	0.022
42	3	0.02	0.02	0.03	0.03	0.055	0.049	0.072	0.074	0.074	0.074	42	3	0.03	0.03	0.03	0.03	0.041	0.038	0.040	0.040	0.044	0.044
49	4	0.01	0.02	0.02	0.02	0.076	0.087	0.125	0.107	0.107	0.107	49	4	0.01	0.02	0.02	0.03	0.067	0.058	0.153	0.125	0.125	0.125
56	5	0.03	0.02	0.03	0.03	0.207	0.174	0.260	0.240	0.240	0.240	56	5	0.02	0.02	0.03	0.03	0.124	0.136	0.256	0.231	0.231	0.231
64	6	0.01	0.02	0.02	0.02	0.176	0.253	0.295	0.248	0.248	0.248	64	6	0.01	0.01	0.04	0.04	0.130	0.171	0.611	0.528	0.528	0.528
71	7	0.02	0.03	0.03	0.02	0.324	0.474	0.498	0.366	0.366	0.366	71	7	0.02	0.02	0.03	0.03	0.304	0.424	0.757	0.779	0.779	0.779
79	8	0.02	0.02	0.02	0.02	0.329	0.430	0.391	0.401	0.401	0.401	79	8	0.02	0.02	0.02	0.02	0.420	0.595	0.641	0.548	0.548	0.548
86	9	0.02	0.02	0.02	0.02	0.388	0.470	0.414	0.430	0.430	0.430	86	9	0.02	0.02	0.02	0.02	0.580	0.710	0.785	0.721	0.721	0.721
91	10	0.02	0.02	0.02	0.02	0.380	0.374	0.436	0.533	0.533	0.533	91	10	0.02	0.02	0.02	0.02	0.589	0.601	0.839	0.946	0.946	0.946
99	11	0.03	0.03	0.04	0.04	0.517	0.565	0.699	0.831	0.831	0.831	99	11	0.02	0.02	0.04	0.03	0.522	0.602	1.385	1.657	1.657	1.657
105	12	0.03	0.03	0.03	0.03	0.394	0.567	0.525	0.689	0.689	0.689	105	12	0.01	0.01	0.03	0.02	0.294	0.317	1.181	1.079	1.079	1.079
113	13	0.02	0.02	0.02	0.02	0.323	0.337	0.413	0.512	0.512	0.512	113	13	0.01	0.01	0.03	0.03	0.405	0.329	1.419	1.528	1.528	1.528
119	14	0.01	0.02	0.02	0.02	0.108	0.150	0.252	0.305	0.305	0.305	119	14	0.01	0.01	0.02	0.03	0.356	0.377	0.980	1.020	1.020	1.020
128	15	----	----	0.03	0.04	----	----	0.222	0.073	0.073	0.073	128	15	----	----	0.03	0.03	----	----	1.049	0.905	0.905	0.905
SOYBEAN BEANS																							
99	11	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	99	11	0.01	0.01	0.01	0.01	0.070	0.086	0.046	0.083	0.083	0.083
105	12	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	105	12	0.01	0.01	0.01	0.01	0.131	0.124	0.104	0.165	0.165	0.165
113	13	----	----	----	----	----	----	----	----	----	----	113	13	----	----	----	----	----	----	----	----	----	0.091
119	14	----	----	----	----	----	----	----	----	----	----	119	14	----	----	----	----	----	----	----	----	----	0.084
128	15	----	----	----	----	----	----	----	----	----	----	128	15	----	----	----	----	----	----	0.110	0.000	0.000	0.000
TOTAL SOYBEAN PLANTS																							
28	1	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	28	1	0.03	0.03	0.03	0.03	0.028	0.024	0.030	0.030	0.030	0.030
35	2	0.03	0.03	0.03	0.02	0.03	0.02	0.03	0.03	0.03	0.03	35	2	0.03	0.03	0.02	0.03	0.056	0.052	0.059	0.062	0.062	0.062
42	3	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	42	3	0.02	0.02	0.03	0.03	0.096	0.087	0.112	0.118	0.118	0.118
49	4	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	49	4	0.02	0.02	0.03	0.03	0.143	0.145	0.277	0.232	0.232	0.232
56	5	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.03	56	5	0.02	0.02	0.03	0.03	0.331	0.311	0.516	0.471	0.471	0.471
64	6	0.01	0.02	0.02	0.03	0.03	0.01	0.02	0.03	0.03	0.03	64	6	0.01	0.02	0.03	0.03	0.331	0.437	0.975	0.813	0.813	0.813
71	7	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.03	0.02	71	7	0.02	0.02	0.03	0.02	0.668	0.933	1.374	1.209	1.209	1.209
79	8	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	79	8	0.02	0.02	0.02	0.02	0.827	1.112	1.246	1.073	1.073	1.073
86	9	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	86	9	0.02	0.02	0.02	0.02	1.195	1.428	1.567	1.421	1.421	1.421
91	10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	91	10	0.02	0.02	0.02	0.02	1.302	1.278	1.757	1.917	1.917	1.917
99	11	0.02	0.02	0.03	0.04	0.198	0.270	0.339	0.637	0.637	0.637	99	11	0.02	0.02	0.04	0.04	1.467	1.660	2.869	3.428	3.428	3.428
105	12	0.02	0.02	0.03	0.04	0.207	0.267	0.393	0.707	0.707	0.707	105	12	0.02	0.02	0.03	0.03	1.211	1.437	2.643	2.884	2.884	2.884
113	13	0.01	0.01	0.01	0.02	0.115	0.176	0.149	0.331	0.331	0.331	113	13	0.01	0.01	0.02	0.02	1.058	1.044	2.491	2.773	2.773	2.773
119	14	0.01	0.01	0.01	0.02	0.107	0.167	0.100	0.248	0.248	0.248	119	14	0.01	0.01	0.01	0.02	0.920	1.039	1.931	2.084	2.084	2.084
128	15	----	----	0.01	0.02	----	----	0.140	0.249	0.249	0.249	128	15	----	----	0.03	0.02	----	----	2.440	1.926	1.926	1.926

TABLE 26.—MANGANESE CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (PPM)							ACCUMULATION (KG/HA)						
TREATMENT							TREATMENT						
DAY	N0	N25	N100	I25	I100	I100	DAY	N0	N25	N100	I25	I100	I100
SOYBEAN LEAVES													
35	2	144.33	164.67	130.33	129.67	0.018	0.022	0.022	0.022	0.019			
42	3	163.33	161.67	99.33	105.67	0.045	0.040	0.027	0.029				
49	4	169.33	174.67	120.33	131.33	0.094	0.092	0.074	0.066				
56	5	171.33	193.33	153.33	148.67	0.134	0.146	0.130	0.129				
54	6	153.00	160.00	137.67	141.00	0.209	0.204	0.204	0.179				
71	7	152.67	165.00	133.67	158.00	0.217	0.301	0.261	0.347				
79	8	156.00	171.00	132.33	158.67	0.261	0.371	0.261	0.305				
86	9	150.33	176.33	131.00	160.33	0.290	0.414	0.270	0.358				
91	10	157.00	151.67	117.33	150.33	0.306	0.283	0.253	0.392				
99	11	176.33	199.67	151.67	182.33	0.280	0.335	0.282	0.434				
105	12	141.33	155.00	125.67	154.33	0.220	0.297	0.239	0.354				
113	13	143.67	160.33	126.67	163.67	0.239	0.273	0.255	0.418				
119	14	116.00	155.00	135.00	145.00	0.100	0.108	0.213	0.187				
128	15	-----	131.67	143.33	-----	-----	0.096	0.031	-----				
SOYBEAN BEANS													
99	11	33.00	37.33	33.33	37.67	0.023	0.033	0.016	0.024				
105	12	33.00	37.33	33.33	37.67	0.044	0.046	0.034	0.050				
113	13	30.33	33.67	29.00	33.33	0.066	0.082	0.064	0.097				
119	14	30.33	33.67	29.00	33.33	0.080	0.102	0.085	0.103				
128	15	-----	29.00	33.33	-----	-----	0.089	0.103	-----				
TOTAL SOYBEAN PLANTS													
28	1	86.75	94.61	70.58	70.30	0.008	0.008	0.007	0.007				
35	2	116.78	132.75	106.50	100.37	0.021	0.027	0.025	0.023				
42	3	124.32	119.09	78.44	88.00	0.051	0.044	0.032	0.037				
49	4	128.40	123.23	83.68	89.15	0.114	0.108	0.090	0.081				
56	5	114.39	128.59	100.44	96.42	0.160	0.173	0.164	0.160				
64	6	92.25	96.52	86.14	93.46	0.251	0.250	0.281	0.246				
71	7	86.43	89.53	75.71	89.29	0.257	0.359	0.347	0.438				
79	8	82.15	88.80	63.41	78.90	0.320	0.456	0.348	0.392				
86	9	73.02	82.23	60.59	80.70	0.404	0.562	0.404	0.517				
91	10	75.86	72.29	56.58	70.95	0.449	0.433	0.409	0.607				
99	11	67.94	74.60	67.04	75.30	0.414	0.520	0.484	0.725				
105	12	53.45	63.09	50.23	60.41	0.374	0.477	0.448	0.613				
113	13	53.41	55.58	44.79	57.88	0.426	0.495	0.478	0.736				
119	14	37.17	39.82	43.14	45.15	0.282	0.331	0.331	0.455				
128	15	-----	33.12	29.99	-----	-----	0.317	0.258	-----				
SOYBEAN SHED COMPONENTS													
64	6	-----	-----	-----	-----	-----	-----	-----	-----				
71	7	-----	-----	-----	-----	-----	-----	-----	-----				
79	8	-----	-----	-----	-----	-----	-----	-----	-----				
86	9	-----	-----	-----	-----	-----	-----	-----	-----				
91	10	-----	-----	-----	-----	-----	-----	-----	-----				
99	11	-----	-----	-----	-----	-----	-----	-----	-----				
105	12	-----	-----	-----	-----	-----	-----	-----	-----				
113	13	-----	-----	-----	-----	-----	-----	-----	-----				
119	14	-----	-----	-----	-----	-----	-----	-----	-----				
128	15	-----	-----	-----	-----	-----	-----	-----	-----				
CONTAMINATED BY SOIL SPLASH													
71	7	62.00	62.33	55.00	62.33	0.000	0.001	0.000	0.001				
79	8	62.00	62.33	55.00	62.33	0.005	0.011	0.002	0.004				
86	9	62.00	62.33	55.00	62.33	0.037	0.054	0.024	0.031				
91	10	62.00	62.33	55.00	62.33	0.062	0.063	0.041	0.066				
99	11	34.33	39.00	41.33	44.00	0.036	0.048	0.046	0.065				
105	12	34.33	39.00	41.33	44.00	0.039	0.045	0.055	0.072				
113	13	31.33	31.00	28.33	30.00	0.037	0.041	0.041	0.060				
119	14	31.33	31.00	28.33	30.00	0.033	0.040	0.026	0.044				
128	15	-----	28.33	30.00	-----	-----	0.039	0.044	-----				

TABLE 27.—IRON CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (PPM)							ACCUMULATION (KG/HA)								
TREATMENT				TREATMENT			TREATMENT				TREATMENT				
DAY	NO	N25	N100	125	1100		N25	N100	125	1100		N25	N100	125	1100
SOYBEAN LEAVES															
35	2	729.67	896.00	984.00	1110.67	0.090	0.119	0.163	0.167			0.026	0.047	0.035	0.034
42	3	315.00	345.67	285.67	329.00	0.087	0.085	0.074	0.090			0.022	0.029	0.022	0.028
49	4	182.00	180.00	210.00	229.67	0.101	0.094	0.132	0.123			0.050	0.036	0.070	0.064
56	5	216.67	207.00	257.67	246.67	0.169	0.154	0.220	0.221			0.086	0.066	0.117	0.130
64	6	177.00	180.00	211.67	201.00	0.238	0.228	0.313	0.249			0.115	0.142	0.315	0.265
71	7	163.00	192.00	169.67	187.67	0.229	0.350	0.321	0.415			0.097	0.155	0.224	0.207
79	8	176.00	173.00	154.67	165.67	0.288	0.374	0.304	0.329			0.139	0.194	0.202	0.161
86	9	164.00	190.33	200.00	222.33	0.318	0.453	0.414	0.487			0.209	0.254	0.351	0.346
91	10	154.00	140.33	154.33	176.33	0.294	0.262	0.337	0.468			0.215	0.186	0.333	0.404
99	11	191.00	194.33	205.33	235.00	0.301	0.338	0.361	0.552			0.234	0.319	0.502	0.618
105	12	173.33	186.00	175.67	178.67	0.265	0.355	0.342	0.418			0.320	0.360	0.516	0.596
113	13	178.00	177.67	162.00	193.67	0.288	0.297	0.335	0.496			0.292	0.376	0.427	0.559
119	14	151.33	175.67	140.33	166.33	0.126	0.119	0.215	0.212			0.282	0.331	0.370	0.399
128	15	-----	-----	105.33	107.33	-----	-----	0.078	0.021			-----	-----	0.282	0.229
SOYBEAN SHED COMPONENTS															
64	6	.....	.....	.....	.....	.....	.....	.....	.....			0.086	0.110	0.060	0.094
71	7	.....	.....	.....	.....	.....	.....	.....	.....			0.162	0.157	0.134	0.194
79	8	.....	.....	.....	.....	.....	.....	.....	.....			0.265	0.297	0.233	0.368
86	9	.....	.....	.....	.....	.....	.....	.....	.....			0.324	0.369	0.313	0.400
91	10	.....	.....	.....	.....	.....	.....	.....	.....			-----	-----	-----	0.397
99	11	.....	.....	.....	.....	.....	.....	.....	.....			TOTAL SOYBEAN PLANTS			
105	12	.....	.....	.....	.....	.....	.....	.....	.....			0.043	0.033	0.036	0.046
113	13	.....	.....	.....	.....	.....	.....	.....	.....			0.116	0.165	0.199	0.201
119	14	.....	.....	.....	.....	.....	.....	.....	.....			0.110	0.113	0.096	0.118
128	15	.....	.....	.....	.....	.....	.....	.....	.....			0.150	0.131	0.201	0.187
SOYBEAN PODWALLS															
71	7	148.33	139.67	160.33	175.67	0.001	0.003	0.000	0.002			0.327	0.507	0.546	0.624
79	8	148.33	139.67	160.33	175.67	0.013	0.024	0.005	0.013			0.440	0.592	0.511	0.503
86	9	148.33	139.67	160.33	175.67	0.087	0.120	0.067	0.087			0.613	0.828	0.832	0.920
91	10	148.33	139.67	160.33	175.67	0.152	0.141	0.116	0.190			0.661	0.589	0.786	1.062
99	11	71.33	82.00	104.33	116.33	0.076	0.100	0.112	0.172			0.695	0.868	1.036	1.437
105	12	71.33	82.00	104.33	116.33	0.080	0.095	0.143	0.193			0.826	0.968	1.135	1.401
113	13	80.33	83.33	83.00	86.67	0.093	0.111	0.121	0.169			0.938	1.081	1.116	1.591
119	14	80.33	83.33	83.00	86.67	0.086	0.108	0.077	0.128			0.817	0.927	0.974	1.140
128	15	-----	-----	83.00	86.67	-----	-----	0.115	0.128			-----	-----	0.801	0.774



TABLE 28.—BORON CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (PPM)										ACCUMULATION (KG/HA)									
TREATMENT					TREATMENT					TREATMENT					TREATMENT				
DAY	N0	N25	N100	I100	DAY	N0	N25	N100	I100	DAY	N0	N25	N100	I100	DAY	N0	N25	N100	I100
SOYBEAN LEAVES																			
35	2	42.67	46.33	46.00	55.00	0.005	0.006	0.008	0.008	35	2	36.67	39.67	39.33	30.00	0.002	0.003	0.003	0.002
42	3	36.00	32.33	39.67	36.00	0.010	0.008	0.011	0.010	42	3	25.00	27.00	27.67	27.00	0.003	0.003	0.004	0.004
49	4	38.33	38.33	44.67	40.67	0.021	0.020	0.028	0.022	49	4	25.00	23.33	27.00	24.33	0.008	0.008	0.012	0.009
56	5	37.67	40.00	52.67	49.00	0.029	0.030	0.045	0.044	56	5	23.33	24.33	27.33	26.67	0.014	0.014	0.021	0.021
64	6	40.00	42.00	59.33	48.00	0.052	0.053	0.087	0.060	64	6	27.33	26.67	31.67	30.00	0.035	0.034	0.053	0.040
71	7	39.33	41.67	65.00	56.00	0.055	0.075	0.123	0.124	71	7	24.67	21.33	29.67	28.00	0.038	0.045	0.074	0.073
79	8	44.00	46.00	73.67	67.00	0.072	0.099	0.144	0.134	79	8	27.00	24.33	32.67	29.33	0.057	0.072	0.105	0.080
86	9	40.00	41.67	66.67	61.67	0.078	0.099	0.138	0.133	86	9	25.00	24.00	31.67	32.00	0.073	0.085	0.124	0.115
91	10	42.00	41.67	67.67	59.67	0.079	0.078	0.147	0.160	91	10	27.00	25.67	35.00	32.33	0.079	0.077	0.147	0.153
99	11	49.33	49.67	69.00	67.67	0.077	0.085	0.121	0.158	99	11	26.00	27.33	35.67	34.67	0.067	0.082	0.135	0.174
105	12	34.33	31.00	54.33	53.33	0.052	0.058	0.107	0.125	105	12	23.67	21.67	27.33	26.67	0.069	0.068	0.121	0.125
113	13	36.67	36.33	55.00	54.00	0.059	0.061	0.112	0.138	113	13	24.00	23.33	26.67	25.67	0.071	0.076	0.127	0.131
119	14	45.67	49.33	60.67	57.00	0.038	0.033	0.091	0.072	119	14	25.33	25.67	21.67	22.33	0.065	0.070	0.092	0.086
128	15	-----	61.33	65.67	-----	-----	-----	0.045	0.013	128	15	-----	24.67	22.00	-----	-----	0.088	0.067	-----
SOYBEAN SHED COMPONENTS																			
64	6	37.67	39.33	49.67	45.33	0.003	0.002	0.007	0.003	99	11	29.67	29.67	43.00	41.67	0.021	0.026	0.019	0.028
71	7	40.67	42.33	71.33	53.33	0.005	0.005	0.018	0.008	105	12	29.67	29.67	43.00	41.67	0.039	0.037	0.045	0.058
79	8	40.67	42.33	71.33	53.33	0.007	0.008	0.039	0.016	113	13	38.00	38.00	40.67	44.00	0.082	0.093	0.090	0.128
86	9	40.67	42.33	71.33	53.33	0.011	0.012	0.057	0.024	119	14	38.00	38.00	40.67	44.00	0.101	0.116	0.121	0.139
91	10	37.00	37.33	60.00	53.00	0.015	0.016	0.065	0.029	128	15	-----	40.67	44.00	-----	-----	0.126	0.138	-----
99	11	37.00	37.33	60.00	53.00	0.021	0.021	0.074	0.035	TOTAL SOYBEAN PLANTS									
105	12	37.00	37.33	60.00	53.00	0.025	0.025	0.079	0.039	28	1	63.37	71.53	63.28	59.39	0.006	0.006	0.006	0.006
113	13	37.00	37.33	60.00	53.00	0.029	0.031	0.089	0.050	35	2	40.51	43.85	43.39	45.64	0.007	0.009	0.010	0.010
119	14	37.00	37.33	60.00	53.00	0.048	0.054	0.101	0.068	42	3	32.60	30.44	35.01	32.87	0.013	0.011	0.014	0.014
128	15	-----	60.00	53.00	-----	-----	-----	0.145	0.110	49	4	33.21	32.11	37.33	34.16	0.030	0.028	0.040	0.031
SOYBEAN PODWALLS																			
71	7	58.33	54.67	65.33	60.67	0.000	0.001	0.000	0.001	56	5	31.30	32.92	40.94	38.91	0.044	0.044	0.067	0.064
79	8	58.33	54.67	65.33	60.67	0.005	0.010	0.002	0.004	64	6	33.32	34.25	44.88	38.91	0.091	0.089	0.147	0.102
86	9	58.33	54.67	65.33	60.67	0.035	0.047	0.027	0.030	71	7	32.79	31.34	46.89	41.83	0.098	0.126	0.215	0.205
91	10	58.33	54.67	65.33	60.67	0.056	0.055	0.047	0.065	79	8	36.30	35.05	52.88	47.02	0.141	0.188	0.290	0.234
99	11	31.00	33.00	50.67	47.67	0.033	0.039	0.054	0.071	86	9	35.56	35.46	52.03	47.13	0.197	0.243	0.347	0.302
105	12	31.00	33.00	50.67	47.67	0.035	0.038	0.071	0.080	91	10	38.83	37.88	56.26	47.54	0.230	0.227	0.406	0.407
113	13	38.33	37.00	52.00	49.33	0.044	0.049	0.077	0.097	99	11	36.09	36.26	55.76	48.47	0.220	0.253	0.402	0.466
119	14	38.33	37.00	52.00	49.33	0.041	0.048	0.052	0.073	105	12	31.34	29.91	47.38	42.01	0.219	0.226	0.422	0.427
128	15	-----	52.00	49.33	-----	-----	-----	0.073	0.073	113	13	35.88	34.93	46.41	42.74	0.286	0.311	0.495	0.543
										119	14	38.43	38.51	45.71	43.39	0.292	0.320	0.457	0.437
										128	15	-----	49.80	46.53	-----	-----	0.476	0.401	-----



TABLE 29.—COPPER CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (PPM)					ACCUMULATION (KG/HA)					CONCENTRATION (PPM)					ACCUMULATION (KG/HA)				
TREATMENT					TREATMENT					TREATMENT					TREATMENT				
DAY	N0	N25	N100	N125	DAY	N0	N25	N100	N125	DAY	N0	N25	N100	N125	DAY	N0	N25	N100	N125
SOYBEAN LEAVES																			
35	2	17.33	18.00	14.67	14.00	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.003	0.002	35	2	16.00	15.33	14.00
42	3	11.33	12.00	9.33	10.33	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	42	3	13.67	12.33	15.33
49	4	11.00	11.00	10.33	10.33	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	49	4	11.67	11.67	11.33
56	5	10.33	11.00	10.67	10.33	0.008	0.008	0.008	0.009	0.009	0.009	0.009	0.009	0.009	56	5	9.90	10.67	10.33
64	6	9.10	8.97	9.93	9.30	0.012	0.012	0.011	0.015	0.012	0.011	0.015	0.012	0.012	64	6	6.17	7.17	8.60
71	7	8.33	8.77	10.00	9.33	0.012	0.012	0.016	0.019	0.021	0.016	0.019	0.021	0.018	71	7	5.73	5.80	7.53
79	8	7.43	8.07	9.37	9.33	0.012	0.012	0.017	0.018	0.018	0.017	0.018	0.018	0.017	79	8	3.77	4.53	7.27
86	9	7.70	8.93	11.00	11.33	0.015	0.015	0.021	0.023	0.024	0.021	0.023	0.024	0.024	86	9	4.87	5.17	8.10
91	10	8.53	7.73	10.67	10.67	0.016	0.016	0.014	0.023	0.028	0.014	0.023	0.028	0.028	91	10	4.97	4.37	9.67
99	11	7.40	8.07	11.33	11.67	0.012	0.012	0.014	0.020	0.027	0.014	0.020	0.027	0.027	99	11	3.67	4.17	9.33
105	12	6.87	7.10	10.13	10.60	0.011	0.011	0.014	0.020	0.025	0.014	0.020	0.025	0.025	105	12	4.10	4.47	8.93
113	13	5.47	6.13	8.53	9.30	0.009	0.009	0.010	0.018	0.024	0.010	0.018	0.024	0.024	113	13	4.00	4.70	7.80
119	14	5.30	5.90	7.27	7.53	0.005	0.005	0.004	0.011	0.010	0.004	0.011	0.010	0.010	119	14	3.53	4.27	6.23
128	15	-----	7.03	6.67	-----	0.005	0.005	0.005	0.005	0.001	0.005	0.005	0.001	0.001	128	15	-----	7.53	6.83
SOYBEAN SHEED COMPONENTS																			
64	6	5.53	7.23	7.43	6.80	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.001	0.000	99	11	11.33	12.00	15.33
71	7	4.47	4.20	4.80	5.17	0.001	0.001	0.001	0.002	0.001	0.001	0.002	0.001	0.001	105	12	11.33	12.00	15.33
79	8	4.47	4.20	4.80	5.17	0.001	0.001	0.001	0.003	0.002	0.001	0.003	0.002	0.002	113	13	13.00	14.00	15.33
86	9	4.47	4.20	4.80	5.17	0.001	0.001	0.001	0.004	0.003	0.001	0.004	0.003	0.003	119	14	13.00	14.00	15.33
91	10	4.37	5.57	8.10	9.07	0.002	0.002	0.002	0.005	0.003	0.002	0.005	0.003	0.003	128	15	-----	15.33	16.00
99	11	4.37	5.57	8.10	9.07	0.003	0.003	0.003	0.007	0.004	0.003	0.007	0.004	0.004	TOTAL SOYBEAN PLANTS				
105	12	4.37	5.57	8.10	9.07	0.003	0.003	0.003	0.007	0.005	0.003	0.007	0.005	0.005	28	1	8.87	9.00	9.36
113	13	4.37	5.57	8.10	9.07	0.003	0.003	0.003	0.007	0.007	0.003	0.007	0.007	0.007	35	2	17.00	17.16	14.82
119	14	4.37	5.57	8.10	9.07	0.006	0.006	0.008	0.010	0.010	0.006	0.010	0.010	0.010	42	3	12.20	12.09	11.39
128	15	-----	8.10	9.07	-----	0.016	0.016	0.016	0.016	0.017	0.016	0.016	0.017	0.017	49	4	11.25	11.22	10.89
SOYBEAN PODWALLS																			
71	7	13.13	12.03	15.87	14.83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	56	5	10.15	10.80	10.45
79	8	13.13	12.03	15.87	14.83	0.001	0.001	0.002	0.000	0.001	0.001	0.002	0.001	0.001	64	6	7.62	8.06	9.19
86	9	13.13	12.03	15.87	14.83	0.008	0.008	0.010	0.007	0.007	0.010	0.007	0.007	0.007	71	7	7.13	7.27	8.72
91	10	12.67	11.67	15.33	14.33	0.012	0.012	0.011	0.011	0.015	0.012	0.011	0.015	0.015	79	8	5.74	6.36	8.28
99	11	7.23	7.87	12.00	11.00	0.008	0.008	0.010	0.013	0.016	0.010	0.013	0.016	0.016	86	9	6.89	7.44	9.83
105	12	7.23	7.87	12.00	11.00	0.008	0.008	0.009	0.017	0.018	0.009	0.017	0.018	0.018	91	10	7.68	6.90	11.12
113	13	6.80	6.93	10.33	9.83	0.008	0.008	0.009	0.015	0.019	0.008	0.015	0.019	0.019	99	11	6.51	7.09	11.34
119	14	6.80	6.93	10.33	9.83	0.007	0.007	0.009	0.010	0.015	0.007	0.010	0.015	0.015	105	12	6.98	7.32	11.15
128	15	-----	10.33	9.83	-----	0.014	0.014	0.014	0.014	0.015	0.014	0.014	0.015	0.015	113	13	7.59	8.28	10.53
															119	14	8.05	8.99	10.39
															128	15	-----	11.52	12.03

TABLE 30.—ZINC CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (PPM)							ACCUMULATION (KG/HA)						
TREATMENT							TREATMENT						
DAY	N0	N25	N100	125	1100	1100	DAY	N0	N25	N100	125	1100	1100
SOYBEAN LEAVES													
35	2	29.67	28.67	29.33	27.00	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.004
42	3	30.00	27.33	26.67	28.00	0.008	0.007	0.007	0.007	0.007	0.008	0.008	0.008
49	4	25.67	28.00	33.67	25.67	0.014	0.015	0.021	0.021	0.014	0.015	0.014	0.014
56	5	28.33	27.33	27.67	30.67	0.022	0.020	0.024	0.027	0.022	0.020	0.024	0.027
64	6	31.00	30.00	42.00	29.33	0.041	0.038	0.053	0.036	0.041	0.038	0.053	0.036
71	7	42.33	34.67	35.00	30.67	0.060	0.062	0.067	0.068	0.060	0.062	0.067	0.068
79	8	29.67	31.33	33.67	31.33	0.049	0.068	0.066	0.063	0.049	0.068	0.066	0.063
86	9	29.67	27.33	34.67	34.67	0.057	0.064	0.072	0.074	0.057	0.064	0.072	0.074
91	10	28.67	26.33	33.67	33.67	0.055	0.049	0.074	0.090	0.055	0.049	0.074	0.090
99	11	29.67	31.33	37.33	35.33	0.046	0.055	0.065	0.083	0.046	0.055	0.065	0.083
105	12	24.00	22.00	35.67	27.33	0.037	0.042	0.071	0.065	0.037	0.042	0.071	0.065
113	13	18.33	17.33	29.33	29.67	0.030	0.030	0.061	0.076	0.030	0.030	0.061	0.076
119	14	44.33	34.00	33.33	37.00	0.038	0.021	0.051	0.046	0.038	0.021	0.051	0.046
128	15	-----	24.33	22.00	-----	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018
SOYBEAN STEMS													
35	2	23.67	24.67	24.00	24.00	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.002
42	3	21.33	21.67	23.67	21.00	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
49	4	17.33	15.67	16.67	15.33	0.006	0.006	0.005	0.008	0.006	0.005	0.008	0.006
56	5	21.00	15.00	13.33	18.33	0.013	0.013	0.009	0.015	0.013	0.009	0.015	0.013
64	6	15.00	17.33	16.67	16.67	0.020	0.020	0.022	0.028	0.020	0.022	0.028	0.022
71	7	15.00	10.67	15.00	10.67	0.023	0.023	0.023	0.038	0.023	0.023	0.038	0.028
79	8	10.90	11.33	13.67	11.67	0.023	0.023	0.034	0.032	0.023	0.023	0.034	0.032
86	9	18.00	23.67	21.33	24.33	0.052	0.052	0.085	0.088	0.052	0.052	0.085	0.088
91	10	10.63	8.40	11.20	13.67	0.031	0.031	0.025	0.047	0.031	0.025	0.047	0.065
99	11	8.73	8.97	20.00	21.33	0.022	0.022	0.027	0.108	0.022	0.027	0.078	0.108
105	12	10.83	8.93	10.27	9.43	0.032	0.032	0.029	0.044	0.032	0.029	0.046	0.044
113	13	14.37	10.67	9.17	8.00	0.042	0.042	0.036	0.041	0.042	0.036	0.044	0.041
119	14	10.37	6.53	9.10	6.00	0.026	0.026	0.018	0.023	0.026	0.018	0.039	0.023
128	15	-----	11.00	6.97	-----	0.040	0.040	0.040	0.021	0.040	0.040	0.021	0.021
SOYBEAN SEEDS													
99	11	35.33	35.67	42.67	42.00	0.025	0.025	0.031	0.019	0.025	0.031	0.019	0.028
105	12	35.33	35.67	42.67	42.00	0.046	0.046	0.044	0.045	0.046	0.044	0.045	0.057
113	13	38.00	39.33	40.00	43.00	0.082	0.082	0.096	0.125	0.082	0.096	0.125	0.125
119	14	38.00	39.33	40.00	43.00	0.101	0.101	0.120	0.135	0.101	0.120	0.120	0.135
128	15	-----	40.00	43.00	-----	0.124	0.124	0.124	0.134	0.124	0.124	0.134	0.134
TOTAL SOYBEAN PLANTS													
28	1	20.74	21.72	24.07	20.21	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
35	2	27.91	27.32	28.38	26.91	0.005	0.005	0.006	0.006	0.005	0.006	0.007	0.006
42	3	27.25	25.23	26.01	26.03	0.011	0.011	0.009	0.011	0.011	0.009	0.011	0.011
49	4	22.57	22.92	26.60	21.80	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
56	5	24.99	21.76	21.07	25.41	0.035	0.035	0.029	0.034	0.035	0.029	0.034	0.042
64	6	22.98	23.45	28.65	22.82	0.063	0.063	0.061	0.060	0.063	0.061	0.060	0.060
71	7	28.61	21.77	24.33	20.30	0.085	0.085	0.087	0.112	0.085	0.087	0.112	0.099
79	8	20.08	20.56	22.58	20.94	0.078	0.078	0.111	0.104	0.078	0.111	0.124	0.104
86	9	25.19	27.14	28.92	30.12	0.139	0.139	0.186	0.193	0.139	0.186	0.193	0.193
91	10	22.55	19.71	24.33	25.06	0.133	0.133	0.118	0.176	0.133	0.118	0.176	0.214
99	11	21.02	21.02	31.20	29.37	0.128	0.128	0.147	0.225	0.128	0.147	0.225	0.283
105	12	21.86	19.86	26.80	23.47	0.153	0.153	0.150	0.239	0.153	0.150	0.239	0.238
113	13	23.27	21.46	23.38	23.05	0.185	0.185	0.191	0.293	0.185	0.191	0.293	0.293
119	14	27.40	24.11	26.28	25.82	0.208	0.208	0.201	0.263	0.208	0.201	0.263	0.260
128	15	-----	27.36	27.94	-----	0.262	0.262	0.262	0.241	0.262	0.262	0.241	0.241
SOYBEAN PODWALLS													
71	7	42.33	37.33	46.67	43.00	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000
79	8	42.33	37.33	46.67	43.00	0.004	0.007	0.001	0.003	0.004	0.007	0.001	0.003
86	9	42.33	37.33	46.67	43.00	0.025	0.032	0.020	0.021	0.025	0.032	0.020	0.021
91	10	42.33	37.33	46.67	43.00	0.041	0.038	0.034	0.046	0.041	0.038	0.034	0.046
99	11	21.00	21.00	35.33	32.33	0.023	0.026	0.037	0.048	0.023	0.026	0.037	0.048
105	12	21.00	21.00	35.33	32.33	0.024	0.024	0.050	0.054	0.024	0.024	0.050	0.054
113	13	12.33	12.00	16.00	13.67	0.014	0.016	0.024	0.027	0.014	0.016	0.024	0.027
119	14	12.33	12.00	16.00	13.67	0.013	0.016	0.016	0.020	0.013	0.016	0.016	0.020
128	15	-----	16.00	13.67	-----	0.023	0.023	0.023	0.020	0.023	0.023	0.020	0.020

TABLE 31.—ALUMINUM CONCENTRATION AND ACCUMULATION AS AFFECTED BY ROW SPACING, IRRIGATION, AND TIME

CONCENTRATION (PPM)							ACCUMULATION (KG/HA)									
TREATMENT				TREATMENT			TREATMENT				TREATMENT					
DAY	N0	N25	N100	N125	N1100	N1100	DAY	N0	N25	N100	N125	N1100	N25	N100	N125	N1100
SOYBEAN LEAVES																
35	2	666.67	703.67	836.67	850.00	0.083	0.094	0.141	0.131	SOYBEAN STEMS						
42	3	249.33	303.33	222.33	325.33	0.069	0.074	0.057	0.089	0.026	0.042	0.038	0.026	0.042	0.038	0.039
49	4	109.00	106.00	141.33	164.33	0.060	0.055	0.089	0.088	0.023	0.034	0.020	0.023	0.034	0.020	0.022
56	5	136.00	130.67	167.33	174.00	0.106	0.097	0.143	0.155	0.043	0.029	0.064	0.043	0.029	0.064	0.061
64	6	93.00	97.00	115.67	114.67	0.126	0.123	0.172	0.142	0.065	0.054	0.101	0.065	0.054	0.101	0.125
71	7	87.67	114.33	81.67	88.33	0.123	0.209	0.156	0.195	0.071	0.085	0.245	0.071	0.085	0.245	0.221
79	8	73.67	72.33	39.67	45.67	0.120	0.158	0.078	0.090	0.061	0.095	0.102	0.061	0.095	0.102	0.083
86	9	62.33	91.67	55.00	72.67	0.121	0.221	0.114	0.158	0.055	0.093	0.092	0.055	0.093	0.092	0.066
91	10	62.33	57.00	62.33	79.33	0.119	0.106	0.136	0.210	0.091	0.126	0.111	0.091	0.126	0.111	0.117
99	11	119.00	120.00	108.33	132.67	0.187	0.206	0.190	0.316	0.127	0.097	0.210	0.127	0.097	0.210	0.212
105	12	131.67	145.33	115.33	127.33	0.202	0.277	0.222	0.296	0.182	0.254	0.291	0.182	0.254	0.291	0.448
113	13	149.33	152.67	110.33	136.67	0.243	0.256	0.226	0.350	0.294	0.310	0.421	0.294	0.310	0.421	0.481
119	14	119.67	148.67	101.00	128.00	0.099	0.101	0.154	0.163	0.224	0.219	0.364	0.224	0.219	0.364	0.413
128	15	80.67	95.00	80.67	95.00	0.060	0.060	0.060	0.060	0.222	0.273	0.315	0.222	0.273	0.315	0.345
128	15	80.67	95.00	80.67	95.00	0.060	0.060	0.060	0.060	0.228	0.228	0.186	0.228	0.228	0.186	0.186
SOYBEAN BEANS																
99	11	7.17	8.57	16.33	12.33	0.005	0.005	0.007	0.008	0.005	0.007	0.008	0.005	0.007	0.008	0.008
105	12	7.17	8.57	16.33	12.33	0.009	0.009	0.011	0.017	0.009	0.011	0.017	0.009	0.011	0.017	0.017
113	13	5.60	6.30	3.30	6.93	0.012	0.012	0.015	0.020	0.012	0.015	0.020	0.012	0.015	0.020	0.020
119	14	5.60	6.30	3.30	6.93	0.015	0.015	0.019	0.021	0.015	0.019	0.021	0.015	0.019	0.021	0.021
128	15	3.30	6.93	3.30	6.93	0.010	0.010	0.010	0.021	0.010	0.010	0.021	0.010	0.010	0.021	0.021
TOTAL SOYBEAN PLANTS																
28	1	476.54	373.69	403.27	544.89	0.045	0.045	0.030	0.040	0.045	0.030	0.040	0.045	0.030	0.040	0.054
35	2	599.84	671.26	750.02	752.44	0.109	0.109	0.135	0.169	0.109	0.135	0.178	0.109	0.135	0.178	0.169
42	3	220.94	289.08	190.92	261.65	0.091	0.091	0.108	0.111	0.091	0.108	0.077	0.091	0.108	0.077	0.111
49	4	116.53	96.61	142.36	163.47	0.104	0.104	0.084	0.149	0.104	0.084	0.153	0.104	0.084	0.153	0.149
56	5	122.43	111.86	149.50	169.15	0.171	0.171	0.151	0.280	0.171	0.151	0.244	0.171	0.151	0.244	0.280
64	6	72.31	80.42	127.71	138.01	0.197	0.197	0.208	0.363	0.197	0.208	0.417	0.197	0.208	0.417	0.363
71	7	61.99	76.07	56.24	56.85	0.185	0.185	0.305	0.279	0.185	0.305	0.258	0.185	0.305	0.258	0.279
79	8	46.70	49.15	31.47	32.70	0.182	0.182	0.264	0.162	0.182	0.264	0.173	0.182	0.264	0.173	0.162
86	9	46.63	60.91	39.12	50.43	0.258	0.258	0.417	0.323	0.258	0.417	0.261	0.258	0.417	0.261	0.323
91	10	55.29	47.56	56.30	61.46	0.327	0.327	0.285	0.407	0.327	0.285	0.407	0.327	0.285	0.407	0.526
99	11	68.37	74.83	75.25	91.36	0.416	0.416	0.522	0.879	0.416	0.522	0.543	0.416	0.522	0.543	0.879
105	12	78.50	85.92	81.53	90.02	0.549	0.549	0.650	0.914	0.549	0.650	0.727	0.549	0.650	0.727	0.914
113	13	68.10	63.78	61.57	70.21	0.543	0.543	0.568	0.893	0.543	0.568	0.656	0.543	0.568	0.656	0.893
119	14	52.11	56.28	51.81	60.84	0.396	0.396	0.468	0.613	0.396	0.468	0.518	0.396	0.468	0.518	0.613
128	15	37.07	35.89	37.07	35.89	0.354	0.354	0.354	0.309	0.354	0.354	0.354	0.354	0.354	0.354	0.309
CONTAMINATED BY SOIL SPLASH																
64	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
71	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
79	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
86	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
91	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
99	11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
105	12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
113	13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
119	14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
128	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
SOYBEAN PODWALLS																
71	7	79.33	80.00	83.67	96.00	0.000	0.001	0.000	0.001	0.000	0.001	0.000	0.000	0.001	0.000	0.001
79	8	79.33	80.00	83.67	96.00	0.007	0.014	0.003	0.007	0.007	0.014	0.003	0.007	0.014	0.003	0.007
86	9	79.33	80.00	83.67	96.00	0.046	0.069	0.035	0.048	0.046	0.069	0.035	0.046	0.069	0.035	0.048
91	10	79.33	80.00	83.67	96.00	0.081	0.081	0.061	0.104	0.081	0.081	0.061	0.081	0.081	0.061	0.104
99	11	40.00	45.00	49.67	71.33	0.042	0.055	0.054	0.106	0.042	0.055	0.054	0.042	0.055	0.054	0.106
105	12	40.00	45.00	49.67	71.33	0.044	0.052	0.067	0.120	0.044	0.052	0.067	0.044	0.052	0.067	0.120
113	13	55.33	59.00	40.33	56.33	0.064	0.078	0.059	0.110	0.064	0.078	0.059	0.064	0.078	0.059	0.110
119	14	55.33	59.00	40.33	56.33	0.059	0.076	0.039	0.083	0.059	0.076	0.039	0.059	0.076	0.039	0.083
128	15	40.33	56.33	40.33	56.33	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056



vest recovery was relatively high at 38 percent (0.036 kg/ha). Cu was the only element where seed concentration increased substantially during development.

**Zinc.**—Table 30 shows how Zn behaved in a similar way to the other mobile elements N, P, K, and Cu. Unlike the other mobile elements, however, Zn concentration was not significantly affected by irrigation (except pod walls and seeds), but total plant concentration was significantly increased at narrow-row spacings. Harvest recovery was the highest of all elements at 50 percent (0.12 kg/ha).

**Aluminum.**—As with Fe, the initial Al concentrations were overestimated because of soil contamination resulting from inadequate washing (table 31). Soil contamination may have contributed significantly to the concentrations throughout the season. Collecting nets could not be placed in the narrow rows, so all shed material was collected off the soil surface, resulting in extreme overestimation of Al, Fe, and Mn concentrations. For this reason we discarded the shed material analysis for these elements. Harvest recovery of Al was extremely small, with final seed concentrations being less than 4 ppm.

The leaf analysis data, before pod set, indicate that N, P, Mg, Fe, and Zn were sufficient in both irrigated and nonirrigated plots (13). Al levels classify as low, Cu as low to sufficient, and Mn and Ca as high in all treatments. P levels were low in the nonirrigated plots and sufficient in the irrigated plots, while B levels were sufficient in the nonirrigated and high in the irrigated plots. A fuller discussion of these results is presented in other reports (32, 33).

In general, irrigation resulted in an increased concentration of most of the elements in soybean tissue. Because total dry matter production also was increased by irrigation, the accumulation of nutrients in the irrigated soybeans was significantly greater than in the nonirrigated soybeans for 9 of the 12 elements. Ca, Mg, and Mn were the exceptions, with no significant effect of irrigation on total accumulation.

Effects of row spacing on the tissue concentrations of the elements discussed here was varied and difficult to explain. However, in all elements other than Zn, total accumulation was significantly greater in the 1.0-m rows than in the 0.25-m rows. Thus, irrigation and wide-row spacing acted to increase total nutrient uptake in soybeans.

Irrigation had no significant effect on final seed yield, and wide-row spacings yielded 360 kg/ha less seed than narrow rows. If nutrient supply had been limiting, the irrigated plots should have outyielded the nonirrigated plots, and the 1.0-m rows should

have yielded at least as much as the 0.25-m rows.

Of the relatively mobile elements N, P, K, Cu, and Zn, the proportions of total uptake recovered in the seeds averaged 59.4 percent, 42.9 percent, 35.0 percent, and 27.4 percent for the N25, N100, I25, and I100 treatments, respectively. For the relatively immobile elements Ca, Mg, Mn, Fe, and B, the recoveries were 20.9 percent, 15.1 percent, 14.4 percent, and 10.6 percent for the N25, N100, I25, and I100 treatments, respectively.

From these nutrient recovery values, we conclude that smaller percentages of the total accumulated nutrients were harvested in the seeds in the 1.0-m rows than in the 0.25-m rows and in the irrigated plants than in the nonirrigated ones. The lower recovery values for the I100 treatment resulted from the abortion of a large quantity of partly filled pods late during the seed filling period.

This occurred to a lesser extent in the N100 treatment. The difference in nutrient recovery between the N25 and I25 treatments resulted mainly from incomplete leaf depletion and translocation of the mobile elements to the seeds for the I25 treatment. It is possible that the incomplete depletion could be a result of the delayed maturity of the I25 treatment, which resulted in final seed filling occurring during cool cloudy conditions.

We conclude that we could find no evidence in the mineral nutrition data, of the 12 elements investigated, to disapprove our earlier hypotheses. That is, yield in the irrigated plots was limited by low-radiation levels, by low temperatures, or both, just before maturity, and the 0.25 m rows outyielded the 1.0 m rows because of greater late-season solar radiation interception.

TABLE 32.—CHEMICAL ANALYSIS OF MATURE SOYBEAN SEEDS COLLECTED AT HARVEST, AND QUANTITY OF NUTRIENTS REMOVED BY SEED YIELD AS AFFECTED BY IRRIGATION AND ROW SPACING

NUTRIENT	CONCENTRATION				QUANTITY REMOVED			
	TREATMENT				TREATMENT			
	N25	N100	I125	I100	N25	N100	I25	I100
	-----percent-----				-----kg/ha-----			
N	5.83	5.72	5.96	5.85	146	120	145	123
P	0.57	0.54	0.56	0.56	14.4	11.4	13.7	11.8
K	1.86	1.77	1.80	1.80	46.5	37.3	43.9	38.0
Ca	0.34	0.33	0.30	0.34	8.6	6.9	7.2	7.2
Mg	0.28	0.26	0.26	0.28	6.9	5.5	6.4	5.9
Na	<0.01	<0.01	<0.01	<0.01	<0.3	<0.2	<0.2	<0.2
	-----ppm-----				-----g/ha-----			
Mn	33	31	28	30	82	66	69	64
Fe	130	138	114	131	327	292	278	277
B	37	35	40	41	93	74	98	86
Cu	15	14	17	17	37	30	41	37
Zn	60	57	43	50	152	120	106	105
Al	<3.75	<3.75	<3.75	<3.75	<9	<8	<9	<8



TABLE 33.—ANALYSIS OF VARIANCE RESULTS FOR THE MAIN EFFECTS

Element	Irrigation					Row Spacing				
	Leaves	Stems	Shed Material	Pod Walls	Total Plant	Leaves	Stems	Shed Material	Pod Walls	Total Plant
N Conc	* I>D	* I>D	* I>D	** I>D	+ I>D	ns	ns	ns	* N>W	ns
N Acc	+ I>D	* I>D	* I>D	* I>D	* I>D	* W>N	ns	ns	** W>N	* W>N
P Conc	** I>D	* I>D	+ I>D	** I>D	** I>D	ns	ns	ns	** W>N	ns
P Acc	* I>D	** I>D	+ I>D	* I>D	** I>D	* W>N	ns	ns	** W>N	** W>N
K Conc	* I>D	* I>D	* I>D	* I>D	* I>D	ns	* N>W	ns	* N>W	ns
K Acc	+ I>D	* I>D	* I>D	ns	* I>D	+ W>N	ns	ns	** W>N	* W>N
Ca Conc	* D>I	ns	* D>I	ns	* D>I	ns	ns	ns	ns	ns
Ca Acc	ns	* I>D	ns	ns	ns	** W>N	* W>N	ns	** W>N	* W>N
Mg Conc	ns	ns	ns	* D>I	ns	ns	ns	ns	ns	ns
Mg Acc	ns	* I>D	ns	ns	ns	ns	* W>N	ns	ns	* W>N
Na Conc	ns	** I>D	ns	ns	** I>D	ns	ns	ns	ns	ns
Na Acc	** I>D	** I>D	ns	ns	** I>D	ns	ns	ns	ns	* W>N
Mn Conc	ns	ns	-	ns	ns	* W>N	ns	-	* W>N	* W>N
Mn Acc	ns	ns	-	ns	ns	** W>N	* W>N	-	** W>N	** W>N
Fe Conc	ns	ns	-	ns	* I>D	** W>N	ns	-	* W>N	** W>N
Fe Acc	* I>D	* I>D	-	ns	* I>D	* W>N	ns	-	** W>N	** W>N
B Conc	* I>D	* I>D	** I>D	** I>D	* I>D	ns	** N>W	* N>W	ns	* N>W
B Acc	** I>D	** I>D	* I>D	ns	** I>D	ns	ns	** N>W	* W>N	* W>N
Cu Conc	** I>D	** I>D	** I>D	** I>D	** I>D	ns	ns	* W>N	ns	ns
Cu Acc	* I>D	** I>D	ns	* I>D	** I>D	* W>N	ns	ns	** W>N	* W>N
Zn Conc	ns	ns	ns	* I>D	ns	ns	ns	ns	ns	* N>W
Zn Acc	* I>D	ns	ns	ns	+ I>D	ns	ns	ns	ns	ns
Al Conc	ns	ns	-	ns	* I>D	* N>W	ns	-	ns	ns
Al Acc	ns	* I>D	-	ns	* I>D	* W>N	ns	-	** W>N	* W>N

<sup>1</sup>Significance levels indicated by \* (5 percent level), \*\* (1 percent level), + (10 percent level), and ns for no significant differences. Treatments that resulted in greater nutrient concentration or accumulation are also shown, using the symbols I (irrigated), D (dryland), W (wide or 1.0-m rows), and N (narrow or 0.25-m rows).

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